// THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every other month
JANUARY, MARCH, MAY, JULY, SEPTEMBER, NOVEMBER

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The Utilization of Grassland in East Africa

The potential value of the grasslands of East Africa probably far exceeds that of the arable land which, in the early development stage, has so far made the most spectacular contribution to the economic progress of the territories. It is particularly in relation to what might be termed human values, as distinct from commercial values, that the importance of grassland arises, though the dairy industry in Kenya shows that even commercial values are by no means negligible. It is not too much to say that the whole future of East Africa is bound up with the improved use of its grasslands. The subject falls naturally into three aspects, namely the more efficient utilization of pasture, its influence through live stock in maintaining the fertility of the arable lands, and the improvement of the real well-being of the inhabitants by increased use of meat and dairy produce.

From this point of view particular importance attaches to two articles which appear in the present issue. The first, "Intensive Grazing on Kenya Veld", by J. D. Hall, B.A., M.Sc., and B. Allen, Dip.Agric., Wye, deals with experimental

work in collaboration with a well-known Kenya farmer on the intensive management of pasture land, with application of fertilizers, in a high-altitude moist area. The other, "The Conservation of Green Fodders for the Dry-Season Feeding of Stock", by M. A. French, M.A., Ph.D., is concerned with a complementary aspect of the same general subject.

The article by Hall and Allen provides a mass of useful data concerning the two aspects of intensive grazing and fertilizing and can be recommended to the careful study of stock farmers in cool moist areas. Particular attention is directed to the economics of the use of fertilizers, and before discussing the actual results it would be well to offer some observations on the design of the experiment. Admittedly it was not designed to withstand tests of statistical significance, there being only eight plots with eight different treatments. There is, however, no indication of any positive result from certain of the treatments, for example lime and potash, so that excluding those treatments from consideration we are left with four plots treated with nitrogen and phosphate and four plots without either of these. These latter may be regarded as controls. There are in effect, therefore, during the first two years, four replications of plots receiving nitrogen and phosphate versus four replications of no treatment. We are not informed as to the lay-out of these plots and so cannot form an opinion as to whether they satisfy the requirements of experimental technique. On the face of them, however, the results appear to show a reasonable degree of consistency.

The information as to grazing technique might well have been amplified. It is not sufficiently detailed to indicate whether extraneous factors have been eliminated entirely. Presumably the herd as a whole was moved from plot to plot in rotation, in which case the period on one plot must have been only about three days and the metabolic processes must have overlapped the changes of grazing to an important extent. The statistical results must have been determined largely by the judgment of the co-operating farmer in ringing the changes, and possibly the order in which the plots were grazed would also have some effect.

The main interest centres round the economic results, and some observations are necessary as to the way in which these are computed. Since it was later concluded that the treatments other than nitrogen and phosphate had no recognizable influence, all the plots not receiving nitrogen and phosphate can be regarded as controls, and thus it is possible to avoid basing calculations on the slender basis of one control plot. The nitrogen–phosphate plots gave in 1933 an average yield of 346 gallons per plot, as against 259 gallons in the case of the plots not receiving these ingredients, an increase of 87 gallons per plot or 34 per cent. In 1934 the nitrogen–phosphate plots gave an average of 677 gallons as against 406 gallons on the other plots, an increase of 271 gallons or 67 per cent.

The nitrogen–phosphate dressing cost Sh. 45 per acre per annum, or Sh. 104/99 per plot, and the economic results work out as follows:—

1933

	Per plot
Increase of milk, 87 galls. at 40 cts. Sh.	34/80
Cost of Fertilizer	104/99
Deficit .. Sh.	70/19

1934

	Per plot
Increase of milk, 271 galls. at 40 cts. Sh.	108/40
Cost of Fertilizer	104/99
Surplus .. Sh.	3/41

These results are very different from those calculated on a comparison with the single control paddock No. 5.

In these two years the relatively low rainfall, 31.90 and 34.50 inches, was no doubt a limiting factor. In the three following years there was a great improvement in this respect, the annual falls being 50.10 in. in 1935, 65.70 in. in 1936 and 71.02 in. in 1937. Unfortunately, however, the whole basis of the experiment was changed in 1935 and controls were virtually eliminated. All plots thereafter received nitrogen, though in varying quantities.

The authors, lacking control plots, attempt in Table III to allow for the increased rainfall by reference to the results of plot No. 2 which received the same treatment throughout. This plot in 1935 showed an increase of 40 per cent over the preceding year. It has been assumed, therefore, that any increase over 40 per cent can be attributed to treatment.

It is obvious, of course, that a single plot is not a very dependable basis on which to make numerical estimates. As far as the general result of the experiment is concerned, however, there is a well marked difference between the results on the plots which received nitrogen for the first time in 1935, and the remainder. The percentage increases in milk yield on the former were from 52 to 85 over and above the 40 per cent assumed to be attributable to rainfall; those on the latter were only from 7 to 14 per cent above that ascribed to rainfall. The authors conclude that at least 62 per cent was attributable to treatments.

If absolute figures are used instead of percentages the increases ascribed to treatment are from 61 to 260 gallons per plot in the case of plots receiving nitrogen for the first time. The lowest figure, 61 gallons, is for paddock No. 5, which received no phosphate. The average of the other three is 203 gallons. On the same basis as before, and neglecting paddock No. 5, the economic results were:—

	Per plot
Increase, 203 galls. at 40 cts. ..	Sh. 81/20
Cost of Fertilizer (as quoted for 1936 and 1937)	90/42
Deficit ..	Sh. 9/22

or Sh. 3/95 per acre.

Thus, the combined result during the first three years was a deficit amounting to Sh. 76 per plot or Sh. 32/58 per acre.

From this stage, the authors have strayed into the field of conjecture. The yield of milk continued to rise after 1935. From the fact that there was an apparent increase of at least 62 per cent due to the application of nitrogen and phosphate in 1934 and 1935, it has been assumed that 62 per cent of the total yield in subsequent seasons could also be ascribed to the same influence. On this basis there would appear to have been an appreciable surplus above the cost of fertilizer over the period as a whole. The premise, however, is a conjectural one, lacking the direct evidence of control plots during the late stages of the experiment and the figures of profits must, therefore, be taken with reserve. Over the past three years there was an average deficit, using nitrogen and phosphate, of about Sh. 10 per acre; over the last three years, on the authors' assumption, there was an average profit of Sh. 36 per acre from plots 6 and 7.

The experimental work is worthy of attention as a first contribution to an important subject. It will be observed that the milking capacity of the cows used was much above the average level. Even with the best possible treatment, of course, results cannot be obtained from stock not capable of giving them. Breeding and feeding must go hand in hand.

The figures of carrying capacity and milk yield per acre on the plots are of interest as showing what similar land under similar treatment is capable of. It is necessary, of course, to bear in mind the basis of the figures as compared with those in common use. The carrying capacities given are maximum capacities; the number of animals was adjusted to the full capacity of the paddocks, and other grazing was available in the dry seasons. In regard to the milk yield per acre this should not be compared with the case of the ordinary farm without making allowance for the land required for maintenance of the necessary complement of heifers and calves; it is not clear how far this was covered by grazing of "followers" in the paddocks.

In the article on fodder conservation attention is rightly directed to the wastage involved in the prevalent practice of leaving portions of the rainy season growth to mature in situ. Analyses are quoted showing the detrioration in composition which sets in towards maturity, and reference is made to the losses from fire, dessication and seed production which occur in practice. These statements may be read in conjunction with "A Note on Butter Production and Prices" published in this Journal, March 1938 (page 381) in which attention is called to the strongly marked seasonal variation in production of butter in Kenya. "The seasonal range of production is very considerable, exports in the lowest month falling to one-third of the level in the highest month. A large amount of potential production must be lost in the dry seasons." As the author points out, management practices are determined largely by the value of land, by which is meant the real value rather than the commercial value put upon it by speculative activity. This value tends to increase with increase of population and rising standards of living. It is in any case often underestimated and a useful purpose is served by studies which show the way along which live stock husbandry must travel if solid progress is to be achieved.

Intensive Grazing on Kenya Veld

THE EFFECT OF ROTATIONAL GRAZING AND FERTILIZERS ON CARRYING CAPACITY AND MILK YIELDS OVER A FIVE-YEAR PERIOD

By THOS. D. HALL, *B.A., M.Sc. (Agric.), Agricultural Adviser to African Explosives and Industries, Ltd.,* and

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During the same period in which the experiments described by Hall and others in the *S.A. Journal of Science* (see References) were running in the Union of South Africa and Southern Rhodesia, others were started in Kenya, also with the object of determining the effect of fertilizers and rotational grazing on veld with reference to its production and stability.* Of the two that were started in 1930–31 none yielded any data. Ill-health of the co-operator in one case and serious and continuous locust depradations in the other eliminated both experiments. Late in 1932 Allen was successful in finding as a co-operator Mr. J. F. Lipscomb, M'Tarakwa, P.O. Naivasha. Although locusts grazed the first rotation most successfully and two droughty years followed, Mr. Lipscomb never wavered but has proved a prince of co-operators. Without his keenness, efficiency, attention to detail, power of observation of a high standard, and regular records, we should not have these most interesting results to report, results that should help his brother farmers very materially.

ECOLOGICAL CONDITIONS

The farm is situated on the Kinangop plateau at an altitude of approximately 8,500 ft., with a rainfall of 48 to 50 in. Edwards (1935, pp. 155) describes this area as representing one of the main grassland types: that with high moisture and comparatively low temperature at high altitudes. The potential area is only 7,000–8,000 square miles, of which 2,500 are occupied by Europeans. In general the altitude is 6,500 to 9,000 ft. and the rainfall 40–60 in. Most of the area was at one time under forest and practically the whole of it may be regarded as potentially Kikuyu grass country (*Pennisetum clandestinum Hochst.*). He states: "Immediately following the clearing of the forest a herbage consisting of *Pennisetum clandestinum*, generally with a proportion of *Trifolium Johnstonii* Oliv., is formed".

At a later stage in the plant succession when soil fertility has declined, coarse tufted grass species make their appearance. The most important of these is *Pennisetum Schimperi* A. Rich, and in smaller areas *Eleusine Jaegeri* Pilger. On the Kinangop plateau a finer textured grass is associated with the former, namely *Andropogon chrysostachyus* Steud. This stage, says Edwards, lasts a considerable period and the next retrograde step is to a herbage in which *Themeda triandra* Forsk, is dominant. In addition to the loss of organic matter, constant burning maintains the *Themeda.* As organic matter and fertility increase, for example, around homesteads and *bomas* or *kraals, P. Schimperi* reappears and finally *P. clandestinum* and *T. Johnstonii.* The value of *Themeda* for grazing is acknowledged by Edwards, but *P. Schimperi,* the dominant grass in the experi-

*For those who are unfamiliar with the system of rotational grazing, copies of the previous papers referred to above are available from the Nairobi office of I.C.I. Ltd., Box 390.

ments we are about to describe, he states is extremely coarse and unpalatable and of little value as a pasture grass. Starting then with such unpromising material, known locally as "wire grass", the results obtained have been surprising.

Rainfall

The average rainfall for the three years prior to the experiment was 49 inches. For the five years the experiment ran it was as follows:—

1933 ..	31.90 in.	Dry
1934 ..	34.50 in.	Dry
1935 ..	50.10 in.	Normal
1936 ..	65.70 in.	Wet
1937 ..	71.02 in.	Wet
Average ..	50.64 in.	

This average, although confirming the previous one, only emphasizes how unreliable averages are. 1936, with a somewhat lower rainfall than 1937, because of better distribution gave superior milk yields. In Kenya there are two definite rainy seasons known as the "long rains" and the "short rains". At M'Tarakwa the long rains started generally in February and continued to June, with the peak in April with 15.6 in. and 18.6 in. respectively in 1936 and 1937, and in May for the other three seasons. July was the most uniformly dry month of the year, with $1\frac{1}{2}$ in. to 4 in. of rain in August, followed by a drier September. October was the peak month of the short rains, which extended over November and decreased into December, with January again a comparatively dry month. The highest monthly amount for the short rains was 7 in.

Frost

Mr. Lipscomb recorded frosts in January, February and March, as well as in the winter months of June, July and August, also in September and one year in October. He has recorded up to 12°F. and 16°F. of frost.

Soil Type

This is a brown loam on which a response to phosphates had been obtained with cereals and lucerne; we had not heard of any response to nitrogen.

Grass Species

No botanical survey was carried out, but the coarse, tufted dominant, known locally as wire grass, was identified as *P. Schimperi*, and the other main type as *Andropogon chrysostachyus*. This, although sensitive to drought and frost, proved a valuable grass. A few isolated patches of Kikuyu grass were found and small amounts of the wild pinkish-white clover *Trifolium Johnstonii* also occurred in nearly all the paddocks, in a stunted condition.

Experimental Area and Fertilizer Treatments

The experiment consisted of eight paddocks, each $2\frac{1}{3}$ acres in extent. As in our South African experiments, there were originally two paddocks each of the following four treatments: O, P, NP, NPK, but one paddock of each treatment received in addition a dressing of lime, and the duplicates were therefore Ca, PCa, NPCa and NPKCa. The amounts of fertilizer applied were as follows:—

O = No fertilizer.

P = 300 lb. rock phosphate and superphosphate mixture per acre per annum (12.5 per cent W.S.*, 16 per cent C.S.†, 23.5 per cent total P_2O_5).

NP = P as above plus 200 lb. sulphate of ammonia (20.6 per cent N) per acre. One-half of the nitrogen was applied at the beginning of the year and the other half later.

NPK = NP as above plus 70 lb. muriate of potash per acre per annum.

Ca = 1,000 lb. agricultural lime per acre. This was applied only once in five years.

*Water soluble. †Citric soluble.

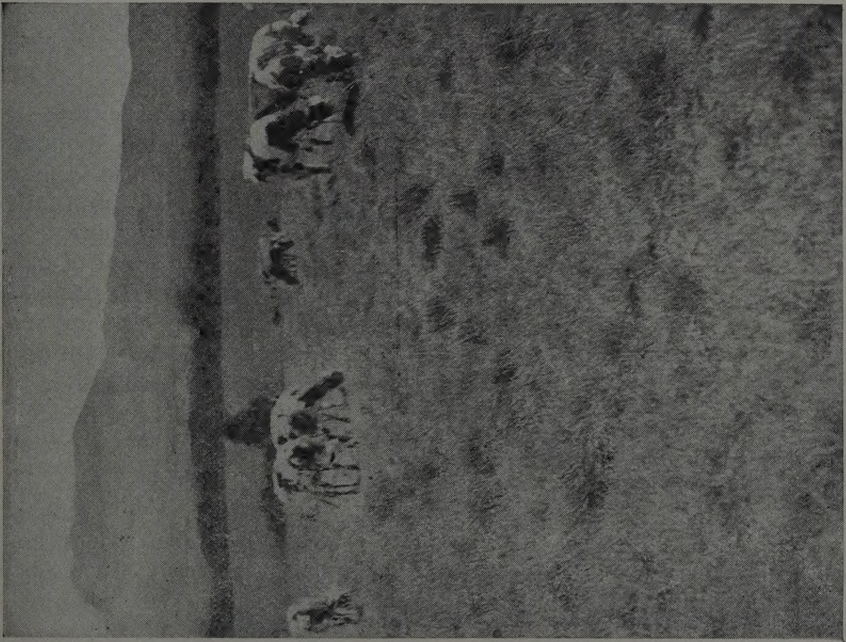

Fig. 1—Typical rough veld grazing of the district

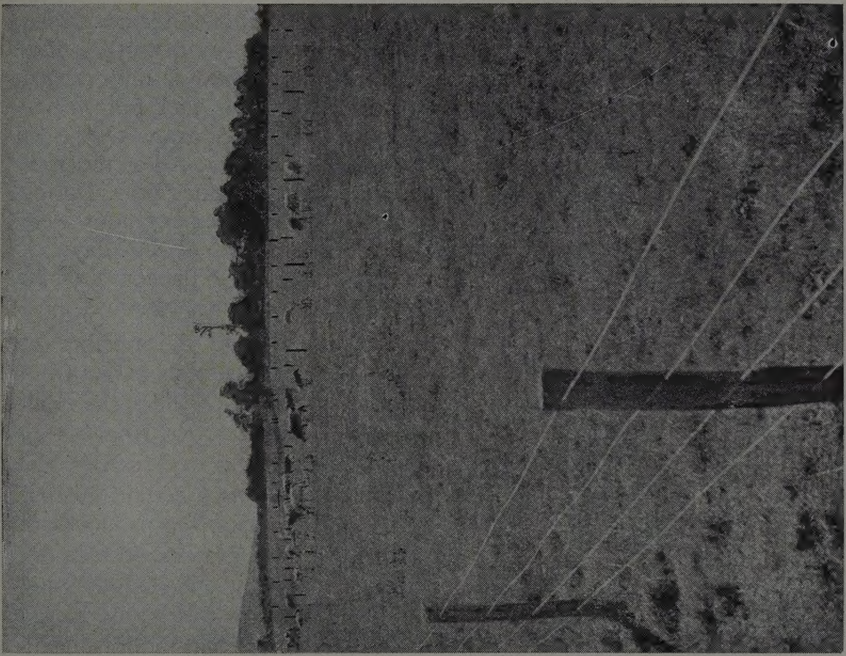

Fig. 2—General view of cows grazing the paddocks. The diminution of the tufted habit of the herbage can be seen by comparison with the grass in the bottom left-hand corner

A change was made in the experiment in the third season (1935) and the following substitutions became effective:—

Paddock 1—NPKCa became N_2PKCa.
" 2—NPK remained NPK.
" 3—NPCa became N_2PCa.
" 4—Ca became NPKCa.
" 5—O became N_2.
" 6—NP became NP (Nicifos).
" 7—PCa became NPCa.
" 8—P became NPK (Nicifos).

It will be noted that the control and lime only paddocks, as such, were abandoned and two fertilizer treatments substituted. The amounts of fertilizers on which these treatments were based were $N_2 = 300$ lb. sulphate of ammonia per acre per annum in three 100 lb. dressings and NP (Nicifos) = 250 lb. Nicifos No. 3 per acre per annum in two 125 lb. dressings. Nicifos No. 3 contains 16 per cent nitrogen and 32 per cent phosphoric oxide.

The first application of fertilizers was given in November, 1932, but owing to severe locust infestation in the two preceding months the grass did not respond readily and grazing did not begin until the 15th December, 1932. Thereafter the basal dressings were applied during the short rains of each year and the top-dressings of sulphate of ammonia and Nicifos as required according to the plan of the experiment.

Grazing Technique

In the first season fifteen recorded grade Ayrshire cows grazed the paddocks as the "first line" and ten yearling heifers were used as followers. The animals remained in the paddocks day and night during the five rotations which lasted 127 days, except for milking and watering. A concentrate ration was fed to the cows in milk as detailed further on.

In the second year the animals grazed in the daytime only for a portion of a day. The number of cows in milk ranged from eight to thirteen, and followers—when they were used—from twelve to fifteen. Concentrates were fed on the basis of yield as in the previous year. During this season eight grazing rotations were completed in a period of 244 days. A ration of kale was fed to the cows in milk during three of the winter rotations.

In the third season the number of animals grazing on the plots varied from fourteen to seventeen, of which the number of cows in milk ranged from eleven to fourteen. During a dry spell in the earlier part of the year a certain number of dry stock grazed on the paddocks at night to clear up tall growth and tufts left ungrazed by the cows. Owing to more favourable weather in this season eleven rotations were completed, the total number of days the paddocks were grazed being three hundred.

Cultural Operations

In none of our co-operative experiments has more attention been paid to the management of the pastures than in this one. In the first grazing season all paddocks except two were mown on three occasions after the removal of the followers and harrowed three times. Paddocks 1 and 2, which were mown twice only, received an extra harrowing.

In the second season all paddocks were harrowed four times and mown once. Numbers 1 and 2, in addition, were mown on two other occasions.

Cultural operations in the third season included several light harrowings to spread droppings, a heavy harrowing after the fourth rotation and a mowing of all paddocks after the fifth rotation.

During 1936 and 1937 harrowing and mowing were carried out whenever it was deemed necessary.

TABLE I

Cow Days and Milk Yield for First Two Seasons

Paddock No.	Fertilizer Treatment 1933–4	1933 Five Rotations 127 days Grazed		1934 Eight Rotations 244 days Grazed	
		Cow days	Gallons of milk. Four rotations only	Cow days	Gallons of milk
1	NPKCa	312	364	404	676
2	NPK ..	318	351	399	667
3	NPCa..	289	322	434	719
4	Ca ..	253	237	247	384
5	O ..	278	281	238	356
6	NP ..	308	347	404	646
7	PCa ..	260	255	299	465
8	P ..	282	261	269	420

The 1933 results show little benefit from fertilizers judged by the cow days and if we ignore the lime treatments and average the other treatments in pairs, we see the following benefits, expressed as per cent: P paddocks over O, 4.1 per cent; NP over O, 12.4 per cent; NPK over O, 18.8 per cent; all N paddocks over no N paddocks, 14.5 per cent. If we consider the milk yields the nitrogen paddocks gave 34.1 per cent more than the non-nitrogen.

For 1934, a year of very similar total rainfall and also of distribution, we see a great improvement. The P paddocks over the O paddocks show a 17.3 per cent increase; the NP over O, 73.5 per cent; and the NPK over O, 65.7 per cent. All the nitrogen paddocks over the non-nitrogen show a 55 per cent increase in cow days, while the milk produced on the paddocks getting nitrogen is 63.5 per cent more than from the non-nitrogen paddocks. These results indicate that the chief benefit is from the nitrogen and that up to the present phosphates have been only of small value. In 1933 the lime paddocks do not give quite as many cow days as the non-limed, but in 1934 the opposite is true to about the same extent, viz. 5 per cent to 6 per cent. In any extensive experiment not laid out to facilitate statistical interpretation the differences must be very great between treatments and very easily discernible before they can be accepted. There is apparently no benefit from potash, though the co-operator on several occasions mentions that potash has increased palatability.

The small benefits from phosphate are not in accordance with the findings of Orr (1931, 24–51) at Molo, Kenya, where sulphate of ammonia and phosphates increased the hay yields about 300 per cent and sulphate of ammonia only about 91 per cent. The effect on palatability and increased resistance to drought are also commented on. The feeding of mineral supplements to dairy cows at Molo, chiefly bonemeal supplemented with rock salt, potassium bicarbonate, ground limestone, ferric oxide and potassium iodide, increased the milk yield in the lactation about 30 per cent, not such a good increase, however, as these paddocks have brought about. That phosphates benefit growth and favour regular breeding has also been proved by du Toit and Bisschop (1929; 1120), and for those reasons, if for no other, they must be used on phosphate-deficient veld.

Observations on the First Year 1933

The ravages of locusts had left the grass in very poor condition just before the experiment started and it took some time to recover. Recorded milk cows gave 20 per cent and 25 per cent less yield in 1933 than in 1932. The second dose of sulphate of ammonia was not put on in May as planned but only in August, owing to drought. As early as the fourth rotation during August the co-operator recorded that when he harrowed as usual

Fig. 4—A fine breeding record attributed to the feeding of mineral-rich grass. Ayrshire cow WINNIE III, born July 1931, calved June 1933, May 1934, April 1935, March 1936, March 1937 and due to calve February 1938. Last record: 5,835 lb. of milk in 251 days, 3.9 per cent butterfat

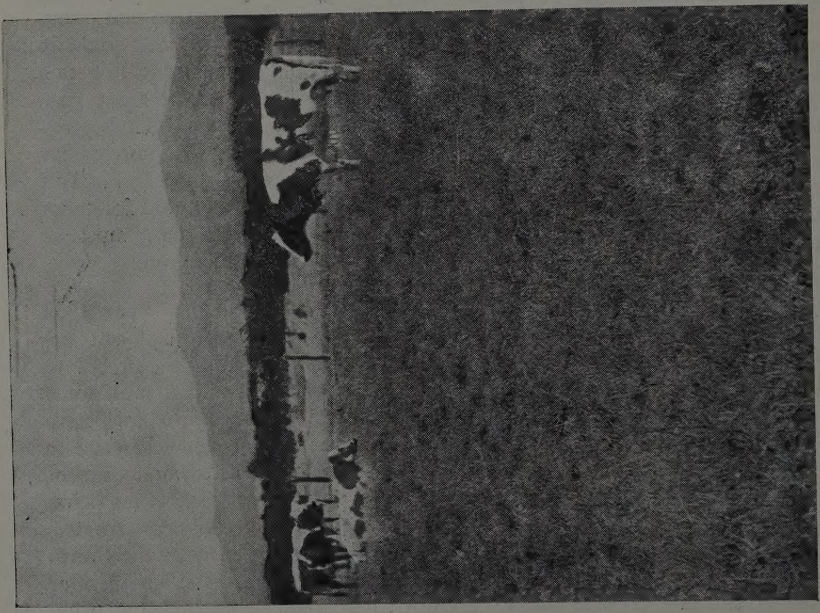

Fig. 3—A closer view of cows grazing the paddocks

after the followers had been removed it was not necessary to mow the four paddocks receiving nitrogen, as they had been so uniformly grazed. He says that those cows which have been in the nitrogen paddocks once or twice arrive at a trot to be ready when the gate is opened, while they show no excitement to reach the other four.

Sward

In the course of the year it was noted that *Andropogon chrysostachyus* had increased on the nitrogen paddocks and was relished by stock but was sensitive to frost and drought. It was also noted that it was a precursor to Kikuyu grass, behind the milking bails in night paddocks or wherever fertility had increased.

At the end of the first year there was considerable improvement in the sward of all the plots compared with the outside grazing. The regular use of the mower had largely eliminated tufts and there were fewer unoccupied spaces. On all the manured plots wild white clover was in evidence. The nitrogen paddocks had grass of a softer texture and less bare ground.

Observations on the Second Year 1934

Rainfall

Although 34.5 in. of rain fell on 162 days, on only thirteen of those days was the fall over 0.5 in. As the sub-soil was dry for the greater part of the year the grass went off quickly in dry spells. Thus, although the total rainfall was fair, its effectiveness was low.

Sward

It was very noticeable how quickly the paddocks recovered in comparison with the unfertilized grass outside when the heavy rains did come. Neither *A. chrysostachyus* nor *P. clandestinum* increased to any extent but *P. Schimperi* responded well to the better control during the second year. The clovers held their own on the fertilized plots, but the season was against their increase and their recovery and growth after drought was a month behind the pennisetums.

Grazing

From experience gained in the first year it was decided to make several changes in the methods of grazing. Hitherto the cows had remained on the paddocks day and night and had been followed by dry cows and heifers. It was noted that the cows did not graze more than an hour after milking at night nor more than an hour before milking in the morning. It was thus decided not to foul the paddocks at night for the sake of two hours' grazing but rather to sleep the cattle in special paddocks not connected with the experiment. It was also noted that the followers were not doing any good in eating off the taller grass left by the cows but rather were overgrazing the more palatable patches already defoliated by the cows. It was decided, therefore, to dispense with followers and use the mower more. In 1936 rather than lose the minerals obtained from the plots it was decided to sleep the cows in the paddock they had just finished grazing. It was observed, furthermore, that if the cows were allowed to graze the paddocks for four hours per day only, they still maintained their milk yield and the utilization of the herbage was thus more efficient. When this amount of grazing could maintain their production, four hours was reckoned a cow day. Exercising, rumination and sleeping were then

done on the paddock previously grazed. Our co-operator remarked:—

"It does not seem to me fair to credit the paddocks with only a fraction of a day's maintenance for the cows when they are kept in the paddocks for only a few hours each day. Surely it is the maintenance of the cow that matters and if a paddock will maintain a cow on only four hours' grazing, it should score higher and not lower than one which has to be grazed for twelve hours in order to maintain a cow."

With this logic we could not but agree, especially as our co-operator went to the trouble to test his hypothesis on several occasions. This is another reason why it is so important to obtain milk yields in evaluating the paddocks.

Milk Yields, Lactation and Concentrates

As Mr. Lipscomb has made some very apposite remarks on this aspect of production, we shall quote him verbatim:—

"I have been using in the paddocks grade Ayrshire cows which start their lactations at about 30 lb. of milk daily and give a total lactation between 500 and 600 gallons of about 4.5 per cent butterfat. To obtain such a lactation on veld grazing, and at the same time to maintain condition, regular breeding and early maturity in the young stock, I consider it necessary to feed a concentrate ration at the rate of 2 lb. for the second gallon and 3 lb. for the third gallon, the veld grazing providing maintenance and the first gallon. The cost of this ration works out at about seven cents per gallon on the lactation or a total of Sh. 35 for concentrates on a 500-gallon lactation. I do not think that a high-grade cow, breeding once a year, can live and milk on less than this. Roughly Sh. 25 of this goes to the second and Sh. 10 to the third gallon.

During the last three rotations I have tried the experiment of cutting off the concentrates from certain cows for varying periods and then returning them and cutting them from different cows. I have found that with cows giving 20 lb. of milk or less there is no falling off in either condition or milk by withdrawing concentrates. With cows giving 30 lb. there is no falling off of milk but there is a slight falling off in condition, but this can be rectified by feeding a small allowance of *posho* (mealie meal). In the present lactation, therefore, I am feeding no cake or bran to any cows giving 20 lb. or less and from 1 lb. to 2 lb. of *posho* to any cow giving between 20 lb. and 30 lb. daily. So far under this treatment most of the cows have increased their milk and none have dropped. I think it can safely be said that a cow on NP or NPK grass will produce 500 gallons of 4.5 per cent milk on only Sh. 7 worth of *posho* (mealie meal) as against Sh. 35 of mixed concentrates when on veld grass, and since it is probable that the virtues of regular breeding and early maturity can be better obtained by the use of fertilizers than of concentrates and since the regular use of fertilizers is definitely a permanent improvement to the land, it should be economic to spend on fertilizers at least Sh. 30 per annum per cow carried."

As the milk yields were recorded daily very close control was kept on the effect of the various paddocks. Sometimes during a drought or dry frosty period maize meal was given to cows producing from one gallon upwards, but then again when the plots were particularly good no maize meal was fed except above 27 lb. milk per day.

Change in Fertilizer Treatments

In discussing Table I it was evident that nitrogen was the dominant factor in increasing carrying capacity and milk yield. The owner felt strongly that if the experiment was continued as heretofore, four paddocks were largely wasted. The NP dressing was considered the most economical and in this 70.5 lb. P_2O_5 and 41.2 lb. nitrogen cost Sh. 45 per acre per annum. This application of fertilizer gave an increase in milk of 312 gallons per paddock or 136 gallons per acre. With milk at 40 cents per gallon the cash value of the extra milk obtained was Sh. 54/40 per acre, which shows an increase over

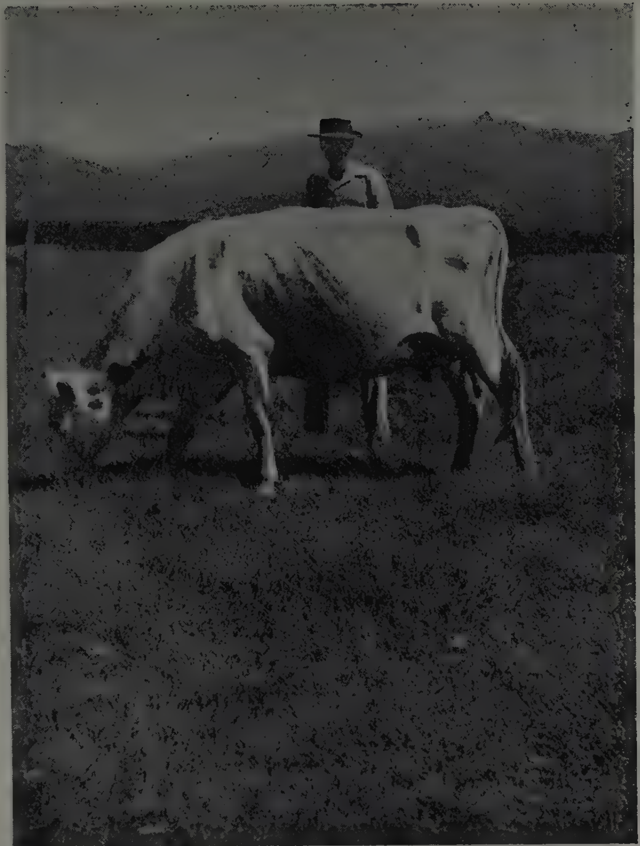

Fig. 5—Ayrshire cow PROMISE, born on the plots in June 1933. Calved July 1935 and gave 5,155.6 lb. of milk in 271 days. Calved again June 1936 and gave 5,851.9 lb. of milk of 4.96 per cent butterfat in 312 days and is in calf again

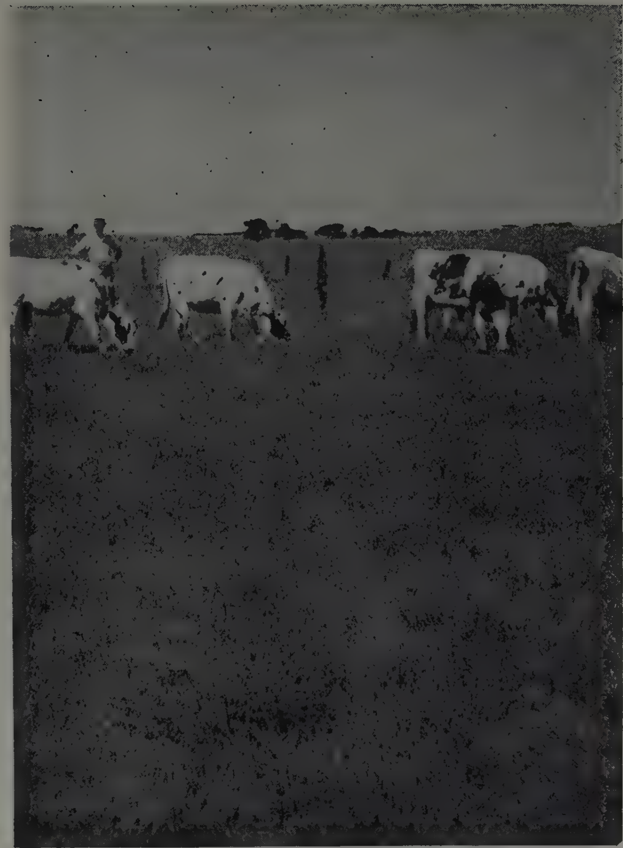

Fig. 6—The sort of young stock the plots are producing. 15- to 18-month-old heifers by imported Ayrshire bull ROWALLAN PROMETHEUS. Three are pure-breds and two are grades

fertilizer costs of Sh. 9/40 per acre. In practice it was more as the co-operator found that on fertilized paddocks he could cut down the concentrate ration without any significant loss of milk. The milk therefore in addition to being more, was produced at less cost.

Bearing these facts in mind it was decided to change the fertilizer applications as already detailed earlier in the paper and again recorded in Table II.

matters, the sward was poor and there was little clover, so that we could hardly expect as much benefit from nitrogen as on plots 7 and 8, which had had phosphates for two years previously. We have tried to arrive at some idea of the nitrogen benefits in 1935 in Table III. There is only one plot that is absolutely the same, No. 2, NPK, and this has been chosen as a basis to evaluate seasonal differences. Plot No. 6 also remained NP

TABLE II

Cow Days and Milk Yields for Three Seasons

Paddock No.	Fertilizer Treatments		1935		1936		1937	
			11 Rotations 300 days grazed		14 Rotations 351 days grazed		13 Rotations *291 days grazed	
	1933–4	1935–6–7	Cow days	Gallons of milk	Cow days	Gallons of milk	Cow days	Gallons of milk
1	NPKCa ..	N2PKCa ..	684	1,044	870	1,418	791	1,216
2	NPK ..	NPK	623	934	870	1,425	791	1,210
3	NPCa ..	N2PKCa ..	724	1,057	832	1,320	791	1,268
4	Ca	NPKCa ..	581	795	832	1,314	763	1,206
5	O	N2	519	684	725	1,107	696	1,080
6	NP	NP (Nic.) ..	678	951	850	1,306	771	1,209
7	PCa	NPCa ..	653	937	762	1,138	733	1,150
8	P	NPK (Nic.) ..	669	947	761	1,147	711	1,111

*291 days out of 371 as dates of grazing were 30–12–36 to 4–1–38

Observations on the 1935 Season

This year with 50.10 in. rainfall, which was well distributed, cannot be compared with the drier year of 1934 with only 34.50 in. In addition all the paddocks were given nitrogen and some were also given phosphates and potash. Furthermore the sward had continued to improve and in several paddocks patches of Kikuyu grass had made their appearance. The clover particularly appreciated the moister conditions and in some places on the paddocks that had been fertilized for three years was ankle-deep and much relished by stock. On No. 5, for instance, although nitrogen has greatly improved

but as the fertilizer used in 1935 was Nicifos (ammonium phosphate) it was not considered so reliable as No. 2 for the reason that Morris (1933, 59) at Mazoe, has stated that he gets better results with phosphates in this form owing to deeper penetration of the P_2O_5 into the soil than with superphosphate, and the soil he worked on, a deep red to brown medium heavy loam, was high in iron.

Lewis, 1937, says: "Since phosphate has no effect on calcium status, it is clear that fertilizers based on ammonium phosphates remove less calcium from the soil than do mixtures based on ammonium sulphate and superphosphate".

TABLE III

NITROGEN BENEFITS IN 1935

Plot No.	Year	Treatment	Cow days	Gallons of milk	Percentage above Seasonal Increase		Extra fertilizer constituent
					Cow days	Gallons of milk	
2	1935	NPK	623	934			
	1934	NPK	399	667	..	..	None
			224 56·1%	267 40·0%			
1	1935	N_2PKCa ..	684	1,044			
	1934	NPKCa ..	404	676			
			280 69·3%	368 54·4%	13·2	14·4	N only
3	1935	N_2PCa ..	724	1,057			
	1934	NPCa.. ..	434	719			
			290 69·1%	338 47·0%	13·0	7·0	N only
5	1935	N_2	519	684			
	1934	O	238	356			
			281 118%	328 92·1%	61·9	52·1	N_2 only
7	1935	NPCa.. ..	653	937			
	1934	PCa	299	465			
			354 118·3%	472 101·5%	62·2	61·5	N only
6	1935	NP (Nic.) ..	678	951			Amount same but ammonium phosphate instead.
	1934	NP	404	646			
			274 67·9%	305 47·2%	11·8	7·2	
8	1935	NPK (Nic.) ..	669	947			NK only but ammonium phosphate
	1934	P	269	420			
			400 148·7%	527 125·4%	92·6	85·4	
4	1935	NPKCa ..	581	795			NPK only in usual form
	1934	Ca	247	384			
			334 135·2%	411 107·0%	79·1	67·0	

The two paddocks which had been well treated for two years show little benefit above the seasonal allowance for rainfall for the extra N only and agree remarkably well. When we consider No. 5, however, which owing to no previous fertilizer treatment was bad botanically, there is an excellent response to N_2 only. There is a very similar response from the lesser amount of nitrogen on No. 7 which had, however, had lime and phosphates for three years. No. 8, which had had phosphates for three years, had also responded better than No. 4 which had had lime only for that time. Considerable benefit may be due to better clover growth on the phosphate plots. It is difficult to show any benefit from phosphates as in the case of No. 7 there appears to be none, while No. 8 shows 49.6 per cent higher cow days than No. 5. Unfortunately ammonium phosphate was used and also potash, although it cannot be said that 1 and 3 show the

Fig. 7—Owing to the reduction in acreage required to keep the dairy herd, a considerable area has become available for the planting of Pyrethrum, which is a paying crop

slightest benefit from potash, nor 4 and 8. We shall leave it to the last two years' results to indicate whether phosphate has been beneficial.

Hall and Moses (1931, 192) found that nitrogen and phosphates on phosphate-deficient veld at Modderfontein gave considerably higher yields over two seasons than twice as much nitrogen alone. General experience is that you do not get full value for the nitrogen applied unless adequate amounts of phosphate are used. Although we cannot show statistically that the ammonium phosphate plots were superior to those getting their phosphate as a superphosphate and rock phosphate mixture and their nitrogen as sulphate of ammonia, our co-operator was impressed by the rapid growth on both these plots and remarked several times during the year that in ammonium phosphate we appeared to have found the best NP treatment. NP (Nicifos) following NP in No. 6 has given better results than NPK following NPK in No. 2, but it must be remembered that the NPK paddock was on worse soil.

Grazing

Owing to the better rainfall grazing started earlier in 1935 after the summer gap than the previous year, viz. on February 28th, as compared with May 11th, 1934, that is after a gap of 78 days instead of 99 days, and thereafter was continuous up to December 29th, except for a period of five days in October, when a number of cows were dehorned. As this operation upset the milk records the co-operator removed all the stock until the output had become normal again. The eleven rotations were very uniform, varying, over 300 days, from 23 to 31 days per rotation.

Reduction in Concentrates Fed

With the information gained in 1934 that the plots could maintain and keep in milk production a two-gallon cow, the feeding of concentrates for the various rotations for 1935 was adusted as follows:—

Rotation	Minimum lb. milk before feeding began
	lb.
1	20
2, 3 and 4 ..	27·5
5	25
6	20
7	15
8	18
9, 10 and 11 ..	25

On outside grazing Mr. Lipscomb's practice was to feed for every 10 lb. of milk over the first gallon. It will thus be seen that even at the worst period of the year, during the seventh rotation in August, when the weather besides being dry was also cold, the plots successfully provided maintenance plus 15 lb. milk, as against outside grazing which does this for only 10 lb. and then at the most favourable season. The cows averaged for the eleven rotations 18.1 to 19.4 lb. milk per day each.

TABLE IV

TOTAL COW DAYS AND MILK YIELDS FOR 1935, 1936, 1937

Plot No.	Treatment	Cow-days	Order of yield	Milk	Order of yield
				Gallons	
1	N_2PKCa ..	2,365	1	3,678	1
2	NPK ..	2,284	4	3,567	3
3	N_2PCa ..	2,347	2	3,645	2
4	NPKCa ..	2,176	5	3,315	5
5	N_2 ..	1,940	8	2,871	8
6	NP (Nic.)	2,299	3	3,466	4
7	NPCa ..	2,148	6	3,225	6
8	NPK (Nic.)	2,141	7	3,205	7

The paddocks getting the most nitrogen in conjunction with P gave the most milk over three years, closely followed by NPK and NP (Nic.) which also had been fertilized all five years. The paddock with high nitrogen and no phosphate has been consistently last in cow days and milk yield during the same period. The paddock which had lime only for two years and had given results about as bad as O has, however, jumped up to fifth place. The difference between the average of the two best yielding paddocks, Nos. 1 and 3, and the average of the two second best, getting less nitrogen, is only 4 per cent, which is hardly significant. Between the averages of paddocks 4, 7 and 8, compared with No. 5 (N_2) is only 13.1 per cent and there is only 27.5 per cent between the milk yield from No. 5 and the average of 1 and 3. We did find, however, in 1934, that NP over O gave 73.5 per cent greater carrying capacity, while the nitrogen paddocks produced 63.5 per cent more milk than the non-nitrogen. From the 1935 results it is evident that nitrogen alone gave at least 62 per cent more milk, while the benefits from phosphates appear to be 17 per cent to 20 per cent in addition. It would appear, then, that we are justified in calculating at least 62 per cent benefit from fertilizers.

Economic Considerations

The costs per acre for the various fertilizer treatments for 1936 and 1937 are as follows and will be used in assessing the cost of fertilizers per 100 lb. of milk:—

- N=200 lb. sulphate of ammonia in two applications: Sh. 23/50.
- N_2=300 lb. sulphate of ammonia in three applications: Sh. 33/25.
- P=150 lb. double superphosphate 39 per cent P_2O_5: 15/25.
- K=87 lb. sulphate of potash: Sh. 11.
- NP=Ammonium phosphate (Nicifos No. 3): Sh. 34/50.

In Table V the paddocks are put in order of merit according to their total production over three years.

TABLE V

Fertilizer Costs for Total Milk, 1935–7

Plot No.	Treatment	Average gallons per acre per annum	Total milk	Total cost	per 10 gallons
		Gallons	*Gallons*	*Sh. cts.*	*Sh. cts.*
1	N_2PKCa ..	533	3,678	424 35	1 15
3	N_2PCa ..	528	3,645	348 45	95
2	NPK ..	517	3,569	343 37	96
6	NP (Nic.)	502	3,466	238 05	68
4	NPKCa ..	480	3,315	343 27	1 03
7	NPCa ..	467	3,225	267 37	82
8	NPK (Nic.)	464	3,205	313 95	97
5	N_2 ..	416	2,871	243 21	84

The lime applied at the beginning of the experiment five years ago has been neglected in the above calculation. As far as we can deduce potash also has given no benefit. In that case the costs of paddocks Nos. 1, 2, 4 and 8 would be somewhat too high. The treatments giving the lowest cost are the NPCa and NP (Nic.) and it appears from the prices given that ammonium phosphate was the cheapest source of these two ingredients. From the 1934 and 1935 results we concluded that the increased yield of milk due to nitrogenous fertilizer was at least 62 per cent. Applying this to the yield of 3,466 gallons from plot 6 we can ascribe 1,326 gallons of it to nitrogen.

	Sh.	cts.
1,326 gallons at 40 cents ..	530	40
Cost of fertilizer	238	05
	Sh. 292	35

or Sh. 41/76 per acre per annum.

In the case of paddock 7, the next cheapest, the position is:—

	Sh.	cts.
1,235 gallons at 40 cents ..	494	00
Cost of fertilizer	267	37
	Sh. 226	63

or Sh. 32/38 per acre per annum.

In considering the question of whether or not the extra N has been worth while we can compare paddocks 1 and 3 with 2 and 6, all of which had phosphate and nitrogen for five years. Averages of these pairs gives us 144 gallons extra milk over three years for the N_2 series at an extra cost of Sh. 35/25 or, if the milk is evaluated at 40 cents per gallon, the difference is Sh. 22/35 or Sh. 9/71 per acre or Sh. 3/23 per acre per annum. If the labour of the extra spreading is considered there is very little return. If we compare paddocks 1 and 3 with all those getting NP and NPK, then the total in favour of the extra nitrogen is Sh. 93/55 instead of Sh. 22/35. The extra nitrogen can hardly be recommended while the dominant grass is *P. Schimperi,* but when the paddocks have all been changed over to *P. clandestinum,* judged by South African experience very much larger quantities of nitrogen will be required and be profitable. Although Kikuyu grass was dibbled in during 1936 it has made disappointing progress, either because it did not get sufficient rest between grazings or because the organic matter content of the soil in the paddocks was still too low.

From the examination of the fertilizer costs and milk yields an application of 200 lb. sulphate of ammonia in two dressings and 300 lb. of a mixture of superphosphate and rock phosphate or 150 lb. double superphosphate or else 250 lb. of ammonium phosphate in two dressings can be considered profitable on this type of veld in Kenya. In addition to the profit in extra gallons of milk the saving in concentrates must be added. Mr. Lipscomb was quoted earlier as saying that when 500-gallon rotations on the plots and on the veld were compared, the plots saved him Sh. 28 in concentrates per lactation per cow and he thought that this alone justified spending Sh. 30 per cow on fertilizers. We can thus add another Sh. 28 to the profit on the fertilizers per acre per annum. Actually during the last year the plots were keeping the cows without concentrates in body maintenance and the production of 25 lb. of milk compared with 20 lb. three years before. At this high altitude with its cool nights a good deal of energy is consumed in maintaining body temperatures. There were further benefits from the fertilized paddocks and these will be discussed under the following heading.

Calves and Breeding

In 1936 from twenty-four cows used on the plots, twenty-eight live calves were produced in the year, due to several calving twice in the twelve months. In 1937 the figures were thirty calves from twenty-seven cows. It is true there is no statistical proof that this is due to the feeding of mineral-rich young grass, but neither the co-operator nor ourselves can see anything else to which to ascribe it.

Practical farmers reading these records will be inclined to admit that they are better than they themselves obtain and will attribute it to the same reason as we do. We quote from an interim report from the co-operator during 1937:—

> "The good breeding figures reported in previous years have been maintained and the growth of the calves and their health have also been good. This I attribute very largely to the fertilized grass as these conditions have not been general throughout the district. In the past eighteen months I have only lost two calves, one of these was from bloat and the other was a mispresentation and injury at birth. When it is considered that many of the dams have been calving down at twenty-three, twenty-four and twenty-five

months old these results are remarkable. None of the other calves have ever been ill at all and at an altitude like this which normally stunts growth, their gains have been very good indeed.

Last year every cow in the herd calved once and 16 per cent calved twice. These figures are being maintained this year and must, I think, be attributed to the fact that the cows are getting the minerals they require from the grass. The milk figures speak for themselves and show a daily average of a little over 18 lb. per day. The cows are on official test and the butterfat is well over 4 per cent."

The work of du Toit and Bisschop (1929, 1120) on feeding bonemeal to cows rather confirms these observations. Of the cows fed on bonemeal, 66.1 per cent had three calves in three years, while none of the cows getting no bonemeal had three calves. These workers also noted the earlier sexual maturity of the heifers fed on bonemeal and that calves from such mothers weigh 16.5 per cent more at weaning. Moreover at $2\frac{1}{2}$ years calves fed on bonemeal weighed 33.2 per cent more.

Carrying Capacity

The quality of the sward, despite heavy rotational grazing, has improved and so has the carrying capacity, from about three acres per cow to one acre per cow.

The fertilizing of all the paddocks has, unfortunately for the interpretation of the results, coincided with the three wettest seasons and made direct comparison difficult. The grazing period for 1937 was shorter than for 1936, but the carrying capacity during that period was 0.86 acres per cow as compared with 0.96 for 1936. Both were subsequently calculated back to the basis of 365 days. The difference is due to the fact that in 1937 there was a longer summer gap when no grazing took place.

TABLE VI

THE CARRYING CAPACITY AND DURATION GRAZING

	1933	1934	1935	1936	1937
Whole area (acres per cow)	2·86	2·44	1·40	0·99	1·08
N paddocks (acres per cow)	2·49	2·00	—	—	—
No N paddocks (acres per cow)	2·06	3·12	—	—	—
Days of grazing..	127	244	300	351	291
Cow days	2,300	2,694	5,131	6,502	6,047

Butterfat

The butterfat production for the last three years has been 163, 226 and 210 lb. per acre respectively.

Summary and Conclusions

1. An experiment on fertilizing and grazing rotationally eight $2\frac{1}{3}$-acre paddocks of indigenous veld in Kenya by grade and pure-bred Ayrshire cows over a five-year period is described and the effect on cow days and milk yields of the various factors during this time is recorded and discussed.

2. The dominant grass was *Pennisetum Schimperi* A. Rich, locally known as "wire grass", a coarse, tufted and unpalatable perennial. There was also a certain amount of *Andropogon chrysostachyus* Steud, a more paltable and less hardy grass, and small areas of *Pennisetum clandestinum* Hochst. (Kikuyu grass), and the pinkish-white clover *Trifolium Johnstonii* Oliv. Under the cultural, rotational and fertilizer treatment described the wire grass became less harsh and the clover increased considerably on all the fertilized plots except the one getting no phosphates. The Kikuyu grass made most disappointing progress but the cover of the paddocks on the whole improved greatly. It is considered that the organic matter content of the soil is not yet high enough to suit the Kikuyu grass.

3. The fact that these paddocks withstood drought for a longer period than

the outside veld and also recovered from its effects more quickly was also noted, and also that the cows found them far more palatable than the outside veld and were always eager to enter them.

4. On this soil and under these conditions it was not observed that calcium carbonate or potash were in any way beneficial.

5. There was a benefit from phosphates, particularly in stimulating the growth of clovers. There are also other benefits from phosphates discussed in No. 11.

6. The application of nitrogen alone (300 lb. of sulphate of ammonia) gave good results evident to all observers, but when nitrogen (200 lb. of sulphate of ammonia) was combined with phosphates the response was much greater, the milk yields indicating that an increase of at least 62 per cent was obtained on this type of sward on which the dominant is a poor grazing grass. Using 300 lb. instead of 200 lb. of ammonium sulphate combined with phosphates gave an additional yield, but too small to warrant the extra expenditure on this type of veld.

7. The combination of phosphate and nitrogen in the two paddocks Nos. 6 and 7, receiving 200 lb. ammonia and 150 lb. phosphates, gave the lowest cost of production, an increase of Sh. 41/76 in one case and Sh. 32/38 in the other per acre per annum respectively when the extra milk is valued at 40 cents per gallon.

8. The application of 250 lb. per acre of ammonium phosphate (Nicifos) in two dressings, or 200 lb. sulphate of ammonia per acre in two dressings plus 150 lb. of double superphosphate or 300 lb. of a mixture of superphosphate and rock phosphate is economically justified. The ammonium phosphate appears to be the cheapest source of these two ingredients.

9. The carrying capacity of the veld has, under the conditions of this experiment, been increased from three acres per cow to around one acre per cow in five years, though to what extent higher rainfall is responsible it is difficult to indicate.

10. Whereas our co-operator was feeding concentrates for every gallon of milk produced on the veld above the first gallon, he found that the paddocks would give his cows body maintenance and enough for the production of 2 to $2\frac{3}{4}$ gallons except during the driest and frostiest months, when he had to feed from 2 to 3 lb. of maize meal only for each gallon from $1\frac{1}{2}$ gallons upwards. He estimated that he saved at least Sh. 28 per 500-gallon lactation. This too can be credited to fertilizers.

11. Proper pasture management by rotational grazing and the regular use of the mower, and harrow and fertilizers, have had far-reaching effects beyond merely increased production of milk or butterfat:—

(*a*) In building up a permanent asset in the form of pasture of high value and greater carrying capacity and thus liberating former grazing land for the utilization of cash crops such as Pyrethrum.

(*b*) In curing irregular breeding among cows, increasing the number of calves born, improving their general health and maintaining rapid growth.

(*c*) In promoting early maturity among heifers, those born on the plots have been calving down at just over two years, by which time they are well grown and mature enough to become profit earners.

12. In short it seems clear that under the conditions of this farm, with good rainfall and high grade cows, an intensive system of rotational grazing on fertilized veld is a profitable proposition.

ACKNOWLEDGMENTS

We have already acknowledged our great indebtedness to Mr. J. F. Lipscomb for his reliability and meticulous care with the records and for his sound observations. We also wish to acknowledge the work done by Messrs. D. Meredith and S. M. Murray, of African Explosives and Industries, Ltd., in working up some of the records.

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The Appearance of a New Physiologic Form of Stem Rust in Kenya Colony

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During the period 1921–1927 the then Plant Breeder observed that a number of hybrid strains of wheat did not behave consistently in their reactions to stem rust and he considered that this behaviour must be due to the fact that more than one race of stem rust was present in the Colony. In 1928 the then Senior Plant Pathologist investigated the matter, utilizing for the purpose the usual twelve American differential wheats. These showed that two physiologic forms of stem rust were present and these were named K.1 and K.2. They appeared to be identical with the American forms 21 and 17.

The majority of the Kabete hybrids then in course of production showed resistance to both these forms, though one wheat, Kenya Governor, whilst resistant to form K.2 showed susceptibility to form K.1.

In 1930 a new variety of wheat called Reliance, bred in America, was tried at Njoro. This wheat was attacked by rust though it was known to be resistant to the two local strains of stem rust. On investigation this rust proved to be a new form and was called K.3. This appeared to be identical with the American form 34. Both the Kabete hybrid wheats and the Njoro hybrids were found to be resistant to this new form K.3, and in fact resistant to all three forms. In 1931, however, one of the new hybrids named Kenya Standard growing at Machakos, was attacked by stem rust, which proved to be another new form now called K.4. This was a very virulent form of stem rust and all the Kabete hybrids were found to be susceptible to it. This group of low-altitude wheats which were then in course of production were therefore all put out of action. The Njoro hybrids, which were long-term wheats, suitable for medium and high altitudes, had, however, shown themselves to be resistant to this fourth form as well as to the other three and their multiplication and the production of new hybrids from them was continued with confidence. These wheats were unfortunately too long-maturing for the lower altitudes of 5,000 ft. to 6,000 ft. Fortunately there was one wheat which had been first bred at Kabete and subsequently at Njoro, namely No. 58, which was resistant to this new form K.4, as well as to the other three, and was just quick enough maturing to be grown at the lower elevations, and farmers were recommended to grow it. Early in 1936, however, a farmer at Timau reported that a plot of this wheat was being attacked by stem rust. On a visit being paid it was found that there was a plot of Sabanero growing beside the plot of No. 58. Sabanero is a slightly mixed variety of wheat, imported from Peru, which had shown quite good resistance (though of a variable nature owing to mixtures) to all four forms of stem rust. The Sabanero was found to have a moderately severe attack of stem rust, insufficient to damage the grain, but wheat No. 58 was free except for an attack confined to the lower portions of the stems and extending to six inches above ground only. The size of the pustules on this part of the stems was large, of the normal susceptible type. The two wheats had been grown under irrigation and it was thought at the time that the rust was

one of the four known forms, that it had attacked the Sabanero as it sometimes does under favourable conditions (such as humidity consequent on irrigation, coupled with the hot temperatures of Timau) and that the peculiar manifestation observed on the No. 58 might similarly be the result of the irrigation, though this attack on the lower portions of the stems had previously been observed in the case of varieties of wheats susceptible to form K.4 and had been associated with that form in particular.

Samples of rusted straw of both Sabanero and No. 58 were brought down from Timau and given to the Senior Plant Pathologist for testing on seedling plants of the differential hosts.

Inoculation results with the rust samples were in accordance with the rust being the old form K.4, i.e.:

Kenya Governor: 3+
Einkorn: 1−
Reliance: 0
Vernal: 3
58 F. (L.1): 0, with a single 2–3 type of pustule on one leaf
Reward: 3++.

The reaction on No. 58, as indicated above, was solely pale hypersensitive areas on the leaves consistent with strong incompatibility, i.e. resistance to the rust, with the one exception to this, however, of one normal-sized rust pustule. This must have arisen from one spore of a different kind of rust. Where did this spore come from? Each leaf inoculation is usually made by taking the spores of one pustule off the original host with a spatula and spreading them over the seedling leaf. Did one spore from another pustule of a different race of rust, originally on the No. 58 material brought down from Timau, accidentally get on to the spatula? This would assume that two kinds of rust were present at Timau, form K.4. and a new form. This would seem improbable since out of a large number of inoculations this was the only case in which the phenomenon occurred. Did this spore blow into the muslin inoculation cages from the air outside when a door was opened? If so, whence did it come? It is possible that there may have been spores in the air originating from some other country and their arrival whilst these inoculations were being carried out might have been pure coincidence. The bulk of the Timau rust was certainly form K.4 and the attack by this form on the two resistant varieties No. 58 and Sabanero was due to the special conditions.

Whatever the origin of the original rust pustule, its progeny was multiplied and seedling inoculation tests with it showed that No. 58, and in fact most of the new hybrid wheats resistant to all the four known forms were susceptible to this rust, though the susceptibility was generally slight rather than severe. Wheats, however, which were susceptible to form K.4, showed complete susceptibility to this rust, which may be closely related to form K.4. The American series of differential wheats gave reactions similar to form K.4 reactions. It was apparent therefore, that wheat No. 58 was itself a differential to the new form.

At the end of the 1936 season two further cases of rust on No. 58 were found, though this wheat, which was in the hands of some sixty growers, spread over most of the country, elsewhere remained free of rust.

In March 1937 stem rust was found on volunteer crops of No. 58 and Sabanero growing in the Rongai district. Results showed that this rust was similar to the Timau rust. In this year some ten thousand acres were seeded to No. 58 wheat and stem rust was found on the ripening

crop in a number of districts. Fortunately the damage done was generally small, though the crop was badly rusted in a few cases.

A number of identifications of the rust on No. 58 from different districts were made and the reactions obtained generally showed the presence of the Timau rust, though on two occasions the readings obtained indicated that the rust was a mixture as form K.2 reactions were also shown.

These results do undoubtedly show the presence of a new form of stem rust and this form, which is presumably the same as the Timau form, has been called K.5.

The departure of the Senior Plant Pathologist on leave early in 1937 and his subsequent transfer has prevented any research work being carried out on the identification of this form of stem rust other than routine inoculation studies.

The American wheat Reliance which was throughout all these inoculation tests used as the differential for form K.3, has continuously shown marked resistance to this new form K.5, as has a Canadian wheat possessing similar resistance called DC 2303. Both these wheats are in fact only susceptible to form K.3, and they have therefore been utilized in new series of crosses with wheats resistant to forms K.1, K.2, K.3 and K.4 These crosses were made in 1936 and 1937, and DC. 2303 was also used in some crosses made in 1935, so that a new breeding programme to combat form K.5 is already well under way.

Two new locally bred hybrids also show resistance to form K.5 and one of them has already reached the bulking stage—over one hundred bags having been sown this year. Furthermore, under normal conditions Sabanero shows resistance to this form of rust, though when grown out of season it has failed to maintain this resistance. In addition, some natural hybrids in a crop of Kenya Standard were found by the grower not to have rusted when his main crop was damaged by form K.4 of stem rust. Selections were made out of this resistant material and three strains which have been carried on likewise show resistance to form K.5.

The appearance of further new physiologic forms of stem rust is of course a possibility but the present Kenya hybrids have shown marked resistance in other parts of the world to a large number of forms and it is hoped that the increased resistance which it is expected to obtain from the new crosses will also prove of value in the eventuality of further new forms of stem rust appearing. The fact that stem rust would appear to be maintained from year to year in Kenya through the uredospore stage and that the aecidia stage on the barberry has never been found in Kenya removes the possibility of new forms arising through hybridization.

Prohibition of the importation of seed wheat into the Colony except in small quantities, which can be treated for destruction of any rust spores present, is a further step in the prevention of new forms of rust appearing in the Colony.

A Study of Coco-nut Palm Yields and Seed Selection in Zanzibar

By ROBERT JOHNS, *N.D.A., C.D.A., C.D.D., A.I.C.T.A., Acting Senior Agricultural Officer, Zanzibar*

The Zanzibar coco-nut industry exports approximately 12,800 tons of copra and 96,700 lb. of oil per annum, valued at £128,800 and £930 respectively. The quality of the copra is very inferior and is classified amongst the world's worst. It is not readily acceptable to the English buyers and finds its way to the cheap Marseilles and Genoa markets. The oil, which is expressed from the better qualities, usually produced by Government estates and a few enterprising manufacturers, is sold along the East Coast of Africa, and in Egypt, Arabia and South Africa.

The above figures by no means represent the total production of the industry, as large numbers of nuts are consumed within the Protectorate, probably on the average one nut per house per day, equivalent to 50,000 nuts per day.

It is not possible to estimate the acreage of coco-nut palms, because, except for the sandy coastal belts, where one finds pure stands, the coco-nut palm is very often interplanted with clove trees, jak fruit, bread fruit and miscellaneous fruit trees.

Until recent years the industry was in a deplorable state, and it can be stated that the above figures of export only represent about 60 per cent of the true value of the industry to the Protectorate. Certain improvements have, however, been effected recently through a "better-copra" campaign.

The neglect of the coco-nut industry in the past can be attributed to the existence of a clove industry which produces large profits in good crop years, and the tendency of the local landholders, owing to lack of knowledge of the potential value of the coco-nut industry, to neglect it in good clove years and to treat it as a sustenance crop in lean clove years. Even in the latter, coco-nut cultivation and copra manufacture receive little attention, and are only utilized to obtain as large a return as possible with the minimum of effort.

Since 1934 the industry has received the continued attention of the agricultural service with the object of improving and establishing it as a substantial subsidiary to the clove. The efforts of the service have been directed towards the improvement of copra quality by utilizing only ripe nuts, by improved methods of drying and by the provision of superior planting material, which is the subject of this article.

Observations recorded in the majority of coco-nut-growing countries show that conditions of growth and quality of material are similar in many respects to those obtaining in Zanzibar Protectorate. Peasant holdings invariably present an overcrowded appearance and a wide variation within the palm population, while well managed estates present remarkable uniformity. This uniformity is well illustrated in Ceylon and Malaya, where seed selection has been undertaken. The method employed on a well man-

aged estate in Malaya was the selection of seed from well-known high-yielding palms and the establishment of progeny blocks for seed production.

An examination of the Zanzibar plantations shows that very wide variation exists. This lack of uniformity is accounted for by the collection of seed nuts at random from storage heaps in the field. Within the population various types exist, from those possessing a wide open crown with an even distribution of fronds (Fig. 1) to the bunchy-top type illustrated in Fig. 2, which seldom or never bear a nut, and thus wide variations occur in yield of nuts, size, shape and colour.

Fig. 1—Frond orientation of a high yielding palm

Fig. 2—Frond orientation of a low yielding palm

The variation in yield in well illustrated in Table I which consists of records taken from commercially managed Government estates.

TABLE I

ESTATE	1937		1936		1935		Mean per Palm per Annum
	Palms Climbed	Nuts Gathered	Palms Climbed	Nuts Gathered	Palms Climbed	Nuts Gathered	
Mtoni	29,883	283,854	29,267	243,059	28,073	224,093	34·4
Kigomeni ..	6,760	77,770	6,233	57,782	5,718	55,432	40·8
Selem	23,261	356,521	26,204	300,636	40,489	483,673	50·8
Machui ..	58,799	917,875	56,623	754,894	48,201	850,937	61·6
Dunga ..	22,446	306,554	22,830	302,841	21,942	249,682	51·2
Chukwani ..	27,729	307,500	24,434	242,102	28,687	285,540	41·2
TOTAL ..	168,878	2,250,074	165,591	1,901,314	173,110	2,149,357	
						MEAN ..	41·76

These figures do not, however, express the complete extent of the variation, as in commercially managed estates only palms bearing sufficient nuts to make them sufficiently attractive to climb are recorded and the low yielders are omitted.

A truer indication of the variation in nut yield is shown in Table II in which the figures represent the mean nut yield over a five-year period, and are extractions at random from an experimental block where a large number of palms are being individually recorded.

The variation in size can also be indicated from similar records, and Table III shows the number of nuts required to make one ton of copra on a number of estates widely distributed in the Protectorate. These figures do not, however, give the true variation of individual trees as they are records from groups of palms and as such only indicate average nut size in different areas.

TABLE II

Palm No.	Number of Nuts per Annum					Mean
	1933	1934	1935	1936	1937	
1	7	12	35	22	17	18
2	22	36	53	43	34	37
3	—	2	20	35	19	15
4	51	112	51	67	107	77
5	35	29	44	39	25	34
6	16	11	45	38	11	24
7	7	23	31	42	15	23
8	37	64	55	40	34	46
9	1	3	21	16	31	14
10	6	4	5	—	5	4
11	—	—	—	—	9	1
12	1	2	1	23	26	8
13	1	3	10	4	3	4
14	7	22	18	5	20	14
15	32	37	26	94	38	45
16	10	4	21	4	1	8
17	23	36	35	33	6	26
18	41	60	16	112	51	56
19	—	7	—	—	2	1
20	—	23	3	1	6	6
21	13	35	27	32	31	27
22	3	8	3	6	15	7
23	4	21	13	26	45	21
24	11	11	5	57	36	24
25	11	22	3	—	6	8
26	19	33	27	6	23	21
27	—	15	—	12	44	14
28	20	13	—	1	14	9
29	—	—	—	6	14	4
30	17	12	37	144	39	49

Mean annual yield per palm .. 21 nuts.

TABLE III

Number of Nuts to Produce One Ton of Copra

Location	Years				Mean for 4-year Period	Nut–Copra Ratio
	1934	1935	1936	1937		
						Lb.
Sandy Coastal Belt ..	5,591	5,609	5,546	5,842	5,663	1 : 0·39
„ „ „ ..	5,972	5,777	5,962	5,914	5,917	1 : 0·38
„ „ „ ..	6,100	5,866	6,230	6,183	6,099	1 : 0·37
Mixed with Cloves ..	5,934	6,261	6,173	6,484	6,231	1 : 0·36
„ „ „ ..	6,397	6,351	6,311	6,464	6,380	1 : 0·35
Coral Outcrop ..	6,535	6,250	6,192	6,642	6,390	1 : 0·35
Clove Area	6,757	6,880	6,426	6,230	6,426	1 : 0·34

Mean nut–copra ratio .. 1 : 0·36 lb.

Nuts collected over wide areas also exhibit a wide variation in shape and in colour of unhusked nut, from different shades of green and yellow to bronze.

As a result of these observations it was concluded that the average Zanzibar yields were low, that the average nut size was small, and that the population as a whole presented a sufficiently wide variation to justify selection.

It was considered that selection could be effected by adopting either of the two well-known methods:—

1. Controlled pollination of high yielders.

2. Collection of seed from high yielders for the formation of isolated progeny seed blocks.

Where practicable, controlled pollination has much in its favour, as the performance of the male parent is known, and the progeny should conform more to type than that produced by the second method. Unfortunately controlled pollination requires a skilled staff and constant supervision. For the Protectorate the second method has therefore been chosen.

Numerous workers have held that owing to natural cross-fertilization it is difficult to predict the performance of the progeny and that only about 60 per cent breed true to type, but in the view of the writer this figure is too low. Breeding experiments with naturally cross-fertilized perennial forest trees in European countries showed that trueness to type was manifested to a maximum of 80 per cent in the progeny; and also observations in Ceylon and especially in Malaya show that a selection carried out by the second method produces remarkable uniformity in yield and a high figure for trueness to type. One cannot without trial predict the performance of coconut palm progeny, but it can be stated that observations indicate that trueness to type may possibly occur to the extent of 80 per cent.

The details of the selection procedure are as follows. The Experiment Station is situated approximately in the centre of 3,000 acres of mixed coco-nut and clove tree land which contains a palm population of approximately 45,000 palms. This was considered enough to provide sufficient numbers of palms and to be representative of the local palm population. The whole area was traversed and some 300 palms were selected which exhibited characters of high yield. The selection was limited to 300 as a convenient number to deal with. During the selection isolated palms and palms growing near homesteads or abandoned homesteads were disregarded, and every endeavour was made to avoid the effects of soil fertility drift by selecting an outstanding palm within a group of palms. The characters of high yield were considered to be:—

(i) Large number of visible nuts evenly distributed around the crown.

(ii) Large number of visible immature nuts, buttons, and flowering spathes evenly distributed around the crown.

(iii) Short flower stalks.

(iv) Wide open crowns with evenly distributed fronds.

(v) Freedom from gummosis.

(vi) Absence of immature nut fall.

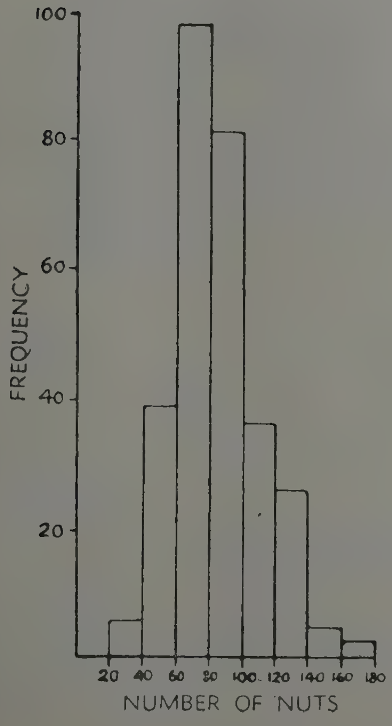
Consideration was also given to previous history if available.

As these selected palms were scattered over 3,000 acres, each palm was labelled with lead seals, and banded with white paint for easy recognition.

It was decided that the local procedure of climbing palms and the dropping of ripe and partially ripe nuts should be adopted and arrangements were, therefore, made to climb each palm every ninety days and to collect the nuts. Accurate records were maintained over the three-year period and the final results obtained for nut and copra yield are shown on Graphs I and II.

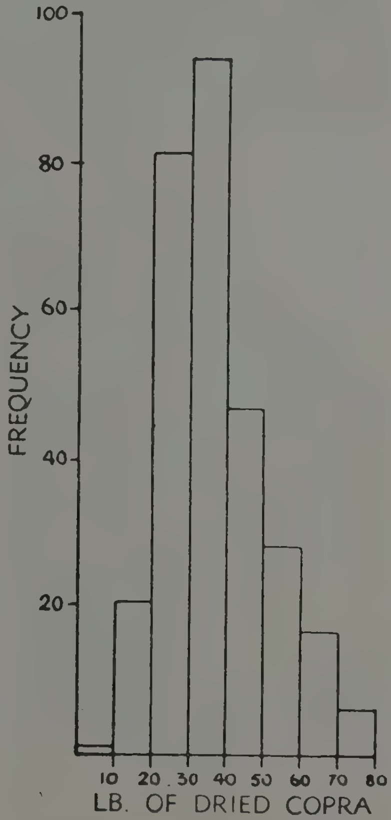
GRAPH I

DISTRIBUTION OF NUT YIELD



GRAPH II

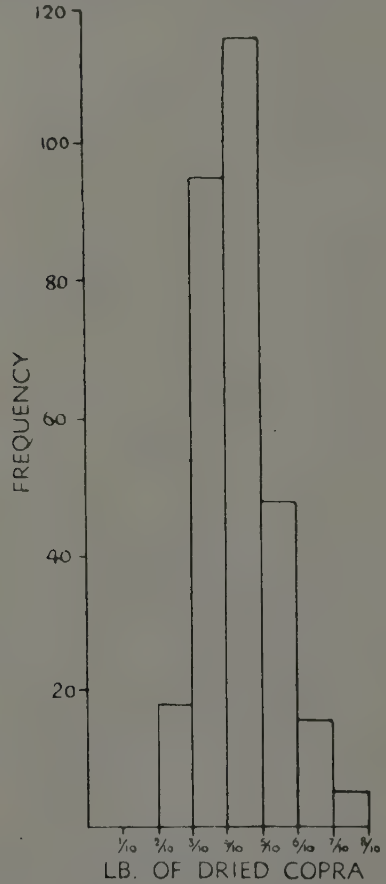
DISTRIBUTION OF COPRA YIELD



Although it was considered that the total number of nuts would be a good criterion of yield, it was also considered necessary to make a study of the nut-copra ratio, of the quality of copra and of the individual oil content. To facilitate this study the nuts were stored in separate compartments, as illustrated in Fig. 3, until fully ripe and then manufactured into copra. The distribution of nut size is appended in Graph III.

GRAPH III

NUT SIZE EXPRESSED IN LB. OF DRIED COPRA



As a result of this study a mass of information was obtained, which can be summarized as follows:—

(*a*) *Number of Nuts.*—The average annual yield per palm over the three-year period showed a surprisingly wide variation, as the highest yielding palm averaged 174 nuts and the lowest only 26. These figures indicate the unreliability of ocular selection, but the average of the selection was 85 nuts as compared with the Zanzibar plantation average of 41 nuts per annum and thus shows a marked superiority.

(*b*) *Weight of Unhusked Nuts.*—Records show that there is a strong positive correlation between number of nuts and weight of unhusked nuts.

(*c*) *Description of Nuts.*—There was a wide variation in colour of the husk, from various shades of green to yellow and bronze, and also in shape and size of unhusked nuts, but none of these characters could be correlated with yield.

(*d*) *Weight of Husked Nuts.*—There was a strong positive correlation between weight of husked nuts and weight of copra.

(*e*) *Yield and Quality of Copra.*—A strong positive correlation was shown between number of nuts and copra yield. Rubbery copra is usually associated locally with immaturity, but the examination of the various parcels of the copra over a period of three years indicates that this character may be inherent. Some palms persistently produced rubbery copra. It may be that this characteristic is associated with a nutritional deficiency and a study of site qualities is indicated.

(*f*) *Nut–Copra Ratio.*—The average ratio of 1:0.44 lb. of copra for the selected trees indicates the smallness of the local nut. The selection, however, showed a variation from 1:0.26 to 1:0.76.

(*g*) *Incidence of Gummosis.* — This disease is widespread in Zanzibar, but some palms appear to show a certain resistance. This factor was taken into

Fig. 3—Compartment storage of nuts of individual palms

consideration during selection of the palms and as far as possible those apparently susceptible were excluded. Subsequent examination of the nuts, however, showed the disease to be present to a fair extent.

Results of the investigations show that the disease does not affect copra quality and only in cases of severe attack does it affect yield.

(*h*) *Oil Content.*—The wide variation in yields of copra suggested that a similar variation might exist in the oil content. A preliminary investigation was made but so far it has not been possible to confirm the initial results. Samples of copra from twenty-six different palms were analysed for oil content and the figures returned showed a variation from 61.7 per cent to 70.9 per cent. A 9 per cent variation is significant and would probably introduce a new factor into selection, but, as already stated, these figures require confirmation.

On the completion of the three-year records, that of each palm was considered. As a result the palms in Table IV were selected as seed bearers for the establishment of seed palm lines and eventually blocks for seed production for distribution to the local public. The palms in Table V were retained as seed bearers for immediate distribution to the public.

TABLE IV

Palm No.	Nut Yield			Mean Nut Yield	Mean Copra Yield
	1935	1936	1937		
					Lb.
7	198	74	126	133	77
13	136	138	119	131	72
114	173	88	101	121	69
116	199	84	102	128	67
156	204	92	70	122	61
158	230	98	74	134	63
194	161	93	45	100	62
241	187	82	114	128	77
258	176	73	73	107	68
262	152	53	72	92	69
271	214	22	125	120	77
279	202	62	100	121	69
300	126	98	122	115	60
	Total		..	1,552	891
	Mean		..	119	68

Nut-copra Ratio 1 : 0·57

TABLE V

Palm No.	Nut Yield			Mean Nut Yield	Mean Copra Yield
	1935	1936	1937		
					Lb.
21	86	67	136	96	55
59	80	47	99	75	52
71	121	55	125	100	56
130	142	113	116	124	59
188	142	109	105	119	53
205	121	85	72	93	57
207	152	94	144	130	56
208	194	144	114	151	54
224	124	81	128	111	55
232	93	87	150	110	56
247	139	79	89	102	55
275	182	38	106	109	53
286	203	44	136	128	53
	Total		..	1,448	714
	Mean		..	111	55

Nut-copra Ratio 1 : 0·49

The superiority of the original 300 and the two final selections is shown in Table VI, where the figures are compared with figures extracted from Tables I and III.

TABLE VI

	Mean nut yield per annum	Mean nut-copra ratio	Number of nuts required per ton of copra
		Lb.	*Nuts*
Final Selection, Table IV ..	119	1 : 0·57	3,929
Second Selection, Table V ..	111	1 : 0·49	4,571
Original Selection Graphs I, II and III ..	85	1 : 0·44	5,091
Zanzibar Estate	42	1 : 0·36	6,158

Some Observations on Farming Economics in the Nakuru District

By V. LIVERSAGE, *B.Sc., M.S., N.D.A., Agricultural Economist, Department of Agriculture, Kenya*

The remarks which follow are based on a tour recently undertaken in the Njoro–Rongai–Solai–Subukia area. The area consists of a cross-section of the Rift Valley from the neighbourhood of Njoro at an altitude of 7,100 ft. through the Rongai and Solai areas, falling to 5,500 ft. in the Solai Valley, and rising again to Subukia on the eastern slopes of the Rift Valley. The coffee areas in the Solai Valley and in Subukia were not included in the survey. Most of the farm records referred to in the following account relate to the open flattish country on the old lake deposits of Njoro, Rongai and the area between Menengai crater and the Thomson's Falls escarpment. They come within the zone designated Rongai–Solai in the Agricultural Census and Crop Reports.

DIFFICULTIES OF PRESENTATION OF DATA

The presentation of data in tabular form presents considerable difficulty under Kenya conditions. The most useful basis for tabulation, when the object is to make useful comparisons, is the factor of production round which the farm economy is organized. This is the factor which imposes the most important limit to the scale or the methods of operation.

In closely settled countries the farmer's approach to his economic problems is made from the starting point that his land is a fixed quantity, at any rate for the time being, and the question is how much labour and how much capital shall be associated with it. In England the usual basis is land, and figures are usually in terms of "per acre" or "per 100 acres". In North America, where labour is relatively scarce and expensive, the nature of operations is most commonly determined by the amount which the farmer with his family can accomplish. The approach here is rather: "What amount of capital (equipment) spread over what area of land, will produce the largest money income?" and the "per farm" basis is more often used in presenting economic data. In a primitive community such as an African tribe, at least where there is no shortage of land, and where not much in the way of capital equipment can be afforded, the labour which can be accomplished by the family is the limiting factor, and the "per family" basis is the most useful. On European farms in Kenya there is usually no shortage of land, and in fact much land remains unutilized. Nor, despite contemporary complaints on the subject, is labour a real limiting factor. It may perhaps be a matter of opinion whether Kenya farming systems are devised with managerial capacity or the amount of available capital as the dominant consideration. Perhaps the right answer is that it is sometimes one and sometimes the other. As bases for tabulation, however, both are open to objection. It seems hardly useful to compare a small mixed farm of 500 acres with a large arable farm of 5,000 acres as if the two were on equal terms merely because each was run by one manager. A basis of "per £1,000 capital", on the other hand, would in-

volve a preliminary valuation of the capital employed. But valuations are too much a matter of opinion and actual book values vary from too many accidental circumstances to make this basis a practicable one. Some farm businesses may be organized round a particular item of equipment, as a tractor or a combined harvester; but capital is interchangeable and the tractor of one farm may be represented by a number of bullock teams on the next, or a harvester may be employed on a small acreage merely because it has been bought cheaply.

It is difficult therefore to find an alternative to the acreage basis for European holdings in Kenya. At the same time it would obviously be misleading to include parts of the farm which are not utilized at all, or merely lightly grazed by work oxen. In this article an attempt is made to get over the difficulty by using the *cultivated* area as the basis of tabulation. This will serve for broad comparisons where live stock play a minor part in the system.

Accounts are compiled on various systems. In some cases the history of a particular crop is followed through, even though it extends over a period of anything up to two years. For instance, cultivations on maize start at the beginning of one year, but the final pay-out by the K.F.A. is not declared until towards the end of the following year. Most accounts refer to a period of twelve consecutive calendar months, but some run from January 1, others from March 1, April 1 or July 1. The costs for one crop are therefore often placed against the returns from the previous crop, the acreage of which might have been very different. On some farms the direct costs are posted by operations, such as ploughing, cultivating, harvesting (labour, *posho* (labour rations), kerosene, repairs, etc., being allocated to each operation), and "overheads" entered separately. In others the compilation is according to items of cost, such as labour, *posho*, fuel oils and grease, repairs and renewals, salaries, general expenses, but the actual headings are different in each case.

For few farms are sufficient data available to attempt an allocation of the various items between the different branches of the farm. On a maize and wheat farm, to take a simple case, the labour cost on the farm as a whole is usually available, but not the amount attributable to maize and wheat separately. Even if an attempt were made by the farmer to do this, considerable practical difficulty would arise, apart from the trouble involved in keeping the records. A field having been cropped with wheat has become infested with couch and other weeds and is followed with maize. The cost of cleaning becomes merged in the ordinary cost of preparation of the land for the maize, and inter-cultivation. But it is in part due to the wheat and must be considered to this extent as part of the cost of wheat, not of maize. Other examples might be given to show that a farm with mixed crops, or crops and live stock, is really an indivisible whole, and that therefore the cost of production of wheat or maize, per acre or per bag, cannot be accurately determined by a process of splitting a diversified farm into constituent parts. The assumptions which it is necessary to make in such a process may in reality decide the answer and involve us in a process of circular reasoning.

It might be thought that it would be possible to make allowance for the differing costs of two or more branches by taking the operations one by one, esti-

mating the cost of labour, oil, etc., for each, and building up a cost of production for each enterprise in this way, using the actual financial accounts as a check on the result. Unfortunately it is found that such estimated costs generally account for little more than half the total expenditure recorded in the books—or even less than half. On one farm, for instance, the cost of native wages as estimated from the number of boys employed on the different operations, the rate of wages paid and the amount done per day, worked out at Sh. 1,465, but the wages recorded in the books reached a total of Sh. 4,062. This is in part due to the numerous "odd jobs", general maintenance, etc., that do not get taken into account in forming an estimate. One might mention also "capital works", but "capital works" have a way of being recurrent. The same thing occurs not only with labour but also with fuel oils. The obvious inference is that farmers who do not set themselves to keep daily records do not really know what is going on on their farms. They may think that each team is ploughing two acres per day when, allowing for stoppages, short ends and so forth, little more than one acre is actually being averaged. This or that boy employed on some "odd job" for the day costs only a few cents and this may appear to be an insignificant matter. It is not realized that in the aggregate the cost of "odd jobs" may take an appreciable proportion of the gross value produced.

It will be realized, then, that it is no easy matter to give a plain statement of the cost of producing maize or wheat or any other crop, based upon fact and not upon fancy.

Some Figures

The following table gives the expenditure incurred per acre of cultivation on a group of arable farms devoted chiefly to maize and wheat. The costs given do not include management and supervision, depreciation or bags, but include seed and *posho* valued at sale value less estimated cost of marketing. On a few farms live stock other than work oxen were kept, but either actual allocations of costs were available or the live stock were of so little comparative importance that a deduction of estimated live stock costs could be made without running the risk of any appreciable distortion of the arable costs. A certain amount, perhaps 60 cents per acre, should be added to the cost of maize to cover losses of bags from wear and tear, theft, etc.

TABLE I

Farm No.	Percentage of Crop Land			Yield per Acre		Running Cost per Crop Acre
	Maize	Small Grains	Other	Maize	Wheat	
	%	%	%	*Bags*	*Bags*	*Sh.*
2	15	85	—	9·6	3·0	18
4	76	20	4	7·4	6·8	18
6	54	19	27	8·9	5·1	18
8	24	64	12	9·9	5·2	29
9	73	27	—	13·6	4·7	18
11	100	—	—	15·0	—	31
16	25	75	—	13·0	Nil	20
18	49	37	14	9·2	1·8	19
19	51	48	1	12·3	6·0	13
20	28	66	6	11·5	4·6	24
22	38	62	—	?	2·8	33
23	30	63	7	7·3	4·8	50
24	76	19	5	11·0	2·1	28
27	100	—	—	11·2	—	36
29	31	69	—	8·9	2·2	26
30	69	31	—	4·8	2·2	21
31	54	37	9	?	?	23
*Average	53	42	5	10·2	3·7	25

*Simple arithmetic mean of the individual figures shown in the table.

TABLE II

DETAILS OF COSTS

FARM No.	Fertilizer	Seed	Wages and Rations	Oils, etc.	Repairs and Renewals	Tractor Expenses	Other Expenses	Total Running Expenses	Salaries	Depreciation
	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.
2	—	—	—	—	—	—	—	18 00	7 85	3 49
4	—	1 67	10 44	2 88	1 77	1 36	37	18 49	15 50	—
6	63	1 82	8 56	3 14	1 26	—	2 24	17 65	6 42	6 87
8	—	—	—	—	—	—	—	29 04	9 72	6 25
9	1 25	2 01	6 98	—	1 07	3 42	3 36	18 09	9 03	5 32
11	—	—	—	—	—	—	—	31 06	9 17	8 40
16	—	4 18	8 85	3 82	93	—	1 92	19 70	—	—
18	36	2 39	9 23	2 33	2 73	—	2 18	19 22	—	—
19	—	2 41	4 72	4 65	92	—	—	12 70	—	—
20		3 65	12 05	3 72	4 99	—	—	24 41	—	—
22	2 12	3 84	8 28	12 82	—	—	5 45	32 51	—	—
23	1 52	4 08	15 27	12 90	8 31	—	7 56	49 64	12 39	3 96
24	37	1 24	8 73	11 04	1 19	—	4 94	27 51	—	—
27	3 25	93	18 99	3 50	3 00	—	6 23	35 90	—	8 29
29	—	3 76	7 83	8 61	4 63	—	81	25 64	—	—
30	—	1 82	9 24	2 72	2 84	—	4 81	21 43	7 55	3 10
31	93	2 72	10 42	—	4 11	2 82	1 94	22 94	3 28	2 06
*Average ..	74	2 61	9 97	5 15	2 69	54	2 99	24 69	—	—
	—	—	—	—	—	—	—	†24 95	—	—

*Simple arithmetic mean of the 14 farms for which details were available on the basis of tabulation adopted.
†Mean of 17 farms, including 3 on which a different accounting basis was followed. (*See* Table III.)

The particulars given in Table III below are the only ones obtained in which the compilation is by operations.

TABLE III

	MAIZE			WHEAT	
FARM No. ..	2	8	11	2	*8
	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.
Seed	1 00	1 26	1 00	5 21	7 71
Fertilizers ..	—	1 20	1 75	—	79
Ploughing ..	2 62	3 40	1 33	2 28	3 38
Planting ..	63	40	}	62	1 54
Discing	70	—	} 2 75	65	—
Weeding ..	1 59	3 40	}	1 79	—
Harvesting ..	3 92	2 70	1 75	1 76	3 94
Shelling ..	31	70	1 76	—	—
Guarding ..	—	—	2 90	—	—
Sacks (Wastage)	—	—	1 43	—	—
Transport ..	2 58	1 20	6 71	38	50
Total Direct ..	13 35	14 26	21 38	12 69	17 86
Share of General Unallocated Expenses ..	5 78	12 78	9 68	5 78	12 78
TOTAL ..	19 13	27 04	31 06	18 47	30 64
Bags per Acre..	9·6	9·9	15·0	2·98	5·33
	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.
Cost per Bag ..	2 90	2 73	2 07	6 20	5 75

*Wheat, barley and oats together, but 87 per cent of the total was wheat.

(Farm No. 8 is a mixed farm and the unallocated general expenses have had to be allocated arbitrarily between cultivation and live stock. This has been done in proportion to the gross output [i.e. value produced] but it is impossible to say precisely what they would have been if there had been no live stock.)

What conclusions can be drawn from the foregoing figures? It is at once obvious that there are very wide differences in acre-costs from farm to farm. In part this is due to what from the statistical point of view might be termed chance variations. This farm was taken over in a state of neglect; on that the tractor was in a state of dilapidation but cash was not available to replace it; on another a portion of the crop failed and had to be replanted; in some cases the accounting data were not sufficiently precise to eliminate year-to-year variation arising out of the accounting practice itself. If figures could be taken over a succession of years for the same farms much of this variation would be smoothed out.

It might have been expected that, since depreciation is not included, the costs on farms devoted chiefly to maize would be higher than those growing mainly small grains. No such relation could be observed in the acre-costs. Comparison with the total crop acreage on each farm and with the yields per acre obtained likewise failed to indicate any definite relation.

Such relations were throughout obscured by individual farm differences, due either to accidental circumstances applying to the year under review, to the nature of the land or to the individuality of the farmer himself. It is suspected that the last-named factor is one of the most important. One of the purposes of studies such as the present is to establish what might be called standards of performance in management, based on comparison with the highest, lowest and average of a sufficient number of actual results.

The mean yields per acre to which the cost figures correspond were 10.2 bags per acre of maize and 3.7 bags per acre of wheat. Assuming that there was no significant difference between the acre-costs of maize and of wheat the average cost per bag of maize was therefore Sh. 2/45 and of wheat Sh. 6/75. This, as before stated, does not include salaries, interest on investment, depreciation or bags. Depreciation as actually entered in the farm books varied from Sh. 2/06 to Sh. 8/40 per crop acre, with an average of Sh. 5/30.

Though examination of records for different farms in the same year failed to indicate any relation between yields and acre-costs, some relation is evident in the following interesting series of costs on a large cereal farm (Farm No. 9). The all-in costs per acre, including management, depreciation, bags and transport to rail are shown below arranged in a two-dimensional table against yield and time.

TABLE IVA

MAIZE—COST PER ACRE (FARM NO. 9)

PERIOD	YIELD PER ACRE, BAGS						
	2–4	4–6	6–8	8–10	10–12	12–14	14–16
	Sh.	*Sh.*	*Sh.*	*Sh.*	*Sh.*	*Sh.*	*Sh.*
1925–9 ..	28 31	–	–	—	37	–	49
1930–3 ..	–	–	37	*51	37	44	–
1934–7 ..	27	21	–	28	38	–	–

*This figure is abnormal due to drastic writing down of oxen values.

The inverse tendency of costs per bag is shown in the following re-calculation.

TABLE IVB

MAIZE—COSTS PER BAG (FARM NO. 9)

PERIOD	YIELD PER ACRE, BAGS						
	2–4	4–6	6–8	8–10	10–12	12–14	14–16
	Sh. c.	*Sh. c.*	*Sh. c.*	*Sh. c.*	*Sh. c.*	*Sh. c.*	*Sh. c.*
1925–9 ..	8 08 9 45	–	–	—	5 08	–	3 22
1930–3 ..	–	–	5 82	*5 96	3 56	3 12	–
1934–7 ..	8 94	4 23	–	2 95	2 79	–	–

**See* note above.

It should be remarked that these figures indicate the variation in costs with varying yields under *given* conditions. They should not be taken as indicating the effect on costs of increasing the yield by measures involving additional expenditure.

One possible cause of variation is the use of tractors. On most farms these are used only for shelling, drawing the harvester-combine, maize planting, and operations where speed is required, the bulk of the field-work being done with oxen. On farms Nos. 22, 23, 24 and 29, however, they were used for the main part of the field operations. The costs on these farms were Sh. 32/50, Sh. 49/64, Sh. 27/51 and Sh. 21/88 per acre respectively. No. 23 is obviously exceptional and, compared with the average, the other three do not provide any particular indictment of the tractor. The following comparisons may be of interest in this connexion; they are the only records obtained which give the requisite details.

TABLE V

EXPENSES PER CROP-ACRE ON FARMS USING MAINLY OXEN AND FARMS USING MAINLY TRACTORS

	Wages and Posho	Oils	Repairs and Renewals
FARMS USING MAINLY OXEN	*Sh. cts.*	*Sh. cts.*	*Sh. cts.*
No. 4	10 44	2 88	1 77
„ 6	8 56	3 14	1 26
„ 9	6 98	3 42	1 07
„ 16	8 85	3 82	93
„ 18	9 23	2 33	2 73
„ 19	4 72	4 65	92
„ 20	12 05	3 72	4 99
„ 27	18 99	3 50	3 00
„ 31	10 42	—	4 11
Average	10 03	3 05	2 31
FARMS USING MAINLY TRACTORS			
No. 22	8 28	12 82	*
„ 23	15 27	12 90	8 31
„ 24	8 73	11 04	1 19
„ 29	7 83	8 61	4 63
Average ..	10 02	11 34	3 53

*Not separately entered.

The only clear difference between these groups is the increase under the heading "Oils" in the lower group, though if the exceptional case of No. 23 is eliminated there would be some countervailing decrease in wages and *posho*. No sound estimate of the probable differences in costs, of course, can be made from such small groups. Also, numerous other factors are involved in a question of the comparative economics of oxen and tractor work, and an adequate treatment of the subject would carry us beyond the scope of the present article. The following pros and cons will occur to the reader:—

In favour of oxen:—

The cost of oil, repairs and depreciation on the tractor is avoided or reduced.

A by-product in the form of manure is obtained.

With careful buying and selling depreciation on oxen can be reduced to a low figure.

Some operations cannot be done by tractors; hence oxen are in any case necessary.

Oxen require little but the waste herbage, etc., on a farm to subsist on, and most farms have sufficient waste land for pasture.

No skilled labour or mechanical ability is required with oxen.

The danger of stoppages at critical times due to mechanical breakdowns, with possible expenditure on motor trips to the nearest workshop or spare parts depot, is avoided.

Oxen serve for transport as well as for cultivation.

In favour of tractors:—

There is less dependence on native labour.

Jobs can be rushed through quickly at critical times.

More thorough work can be done.

There is no loss from disease.

A larger area can be managed by one European supervisor. (This seems to be a doubtful proposition.)

Good second-hand tractors can be picked up cheaply just now, and when this is so, capital outlay may be less on tractors than on the equivalent complement of bullocks.

PYRETHRUM

One or two records of the cost of pyrethrum-growing were obtained incidentally, and these may be of some interest even in the absence of any criterion as to whether they are at all typical.

On farm No. 22 a small experimental block of ten acres was planted in October 1935, followed by a further ten acres planted in April 1937. The farm is at an altitude of less than 7,000 ft. and is in a somewhat dry area, which would certainly not be classed as a typical pyrethrum district. The cost of establishment was not available, but the maintenance and picking costs were as follows:—

PER ACRE	1936	1937
	Sh.	*Sh.*
Picking, Clearing and Drying ..	19	25
Other Costs	2	3
Sh.	21	28
Sales	310 lb.	350 lb.
Cost per lb.	7 cents	8 cents

Admittedly this was carried out as a small experimental sideline, and costs would no doubt increase when the acreage was increased; a permanent drier had been erected but not until the close of the period covered by the above particulars. In due course it would no doubt

be considered that the pyrethrum should bear part of the general charges of the farm. The venture returned a useful little cash surplus, amounting in the second year to nearly £150. In these dry areas the cost of weeding is much reduced, and it would be rash to assume that in such areas pyrethrum cultivation is uneconomic.

Another record is from a somewhat similar altitude. It gives the costs from the time of establishment. The figures are possibly influenced by the fact that there was no European supervisor resident on the holding:—

Per Acre	1935	1936	1937
	Sh.	*Sh.*	*Sh.*
Seed	49	—	—
Wages	65	50	33
Other Expenses	7	5	2
Sh.	121	55	35
Yield	292 lb.	428 lb.	127 lb.
Cost per lb.	41 cents	13 cents	28 cents

A further record is from a high altitude, moist area, a typical pyrethrum area (farm No. 26). Whereas the foregoing were sidelines on farms devoted chiefly to cereals, this one is primarily a pyrethrum proposition, with over eighty acres under the crop. The details are as follows:—

	Per Acre	Per lb.
	Sh.	*Cents*
Wages	58	—
Labour Expenses	1	—
Sacks and Twine	6	—
Transport and Railage	4	—
Miscellaneous	5	—
Land Office Rent	6	—
Total Running Cost	80	20
Salaries	75	19
Depreciation	24	6
Total	179	45
Sold	392 lb.	—

The item "Land Office rent" is, of course, entirely out of proportion to the land actually utilized directly and indirectly for pyrethrum and should be discounted accordingly.

Cattle

The survey was directed mainly towards the costs of arable farming, but some information was obtained on live stock and a few observations on the subject may not be out of place here. One point which struck the writer was the results obtained on the *igoka* grassland (*Cynodon* spp.) which covered most of the area concerned. Much of this country has a dry appearance and an observer without local experience might have expected to find it excellent for beef production but indifferent for dairying. Figures examined did not support this expectation. The yields of butterfat (i.e. actual sales) per cow varied from 70 lb. to as high as 130 lb. The latter was of course managed on intensive lines, calves hand-fed and bull calves killed at birth; it is the highest figure so far obtained by the writer for a grade herd kept for ordinary commercial purposes (i.e. not for sale of pedigree breeding stock).*

The method of arriving at the yield per cow should be made clear. The total sales of butterfat or its equivalent during the year were divided by the average number of cows in the herd during the year, including dry cows but not, of course, in-calf heifers. An average based upon the number actually in milk does not give a true picture because a high apparent yield may be shown over a short lactation period. An average yield of, say, a gallon per day in milk is seen in a different light if it is maintained for only a few weeks. It is appreciated that some of the cows may be retained only for breeding and rearing purposes, but this, after all, is one of the facts in the case. It is necessary for comparative purposes to neglect milk fed

*This has since been exceeded by a record from a more westerly district, showing an average of 160 lb. per cow.

to calves because on so many farms the semi-ranching method is followed and the amount fed is not known.

Three examples of the cost per cow on dairy farms may be of interest, though it would be dangerous to generalize from such a small sample. They provide an interesting contrast because No. 21 is a large farm run on extensive lines, No. 14 is a small intensive proposition and No. 11 is intermediate. The figures represent the total for the herd divided by the average number of cows and thus include the calves, heifers, steers, etc., maintained along with the cows. It is of interest to compare them with the results of a survey of forty-seven dairy farms made in 1932 and published as Department of Agriculture Bulletin No. 6 of 1934.

TABLE VI

EXPENSES AND RETURNS PER COW ON DAIRY FARMS

FARM NO. ..	21	14	11	Average of 47 Farms
Average Yield of Butterfat per Cow	71	130	91	42
EXPENSES PER COW	*Sh. cts.*	*Sh. cts.*	*Sh. cts.*	*Sh. cts.*
Wages and labour rations	28 72	35 84	9 27	15 80
Feeds and minerals ..	10 50	9 72	7 64	6 20
Dip and veterinary.. ..	4 87	15 07	3 59	1 40
Repairs and upkeep	3 13	4 84	5 28	} 7 20
Miscellaneous ..	13 04	5 02	6 05	
Total ..	60 26	70 49	31 82	30 60
OUTPUT PER COW				
Sales of Dairy produce ..	84 00	112 79	78 75	40 40
Credit balance of cattle (stock) account ..	30 38	53 64	24 26*	10 00†
Other sales ..	—	—	—	12 00‡
Total ..	114 38	166 43	103 01	62 40
Surplus ..	54 12	95 94	71 19	31 80

*Increase valued by the writer at Sh. 100 per head for cows and in-calf heifers, Sh. 50 for steers, Sh. 60 for weaner heifers and Sh. 20 for calves.

†No data on increase of stock on hand were obtained, and the figure shown represents merely sales of cattle *less* purchases.

‡These include pigs, eggs, etc., and are included because they are covered by the costs shown. In the other examples the costs of other produce have not been included.

The sales of dairy produce include sales of butter, cheese, etc., and it will clarify the position if the produce is shown as butterfat valued at 90 cents per lb. The credits will then become:—

FARM NO. ..	21	14	11	Average of 47 Farms
	Sh. cts.	*Sh. cts.*	*Sh. cts.*	*Sh. cts.*
Sales of dairy produce ..	64 00	117 00	82 00	38 00
Credit balance of cattle (stock) account ..	30 38	53 64	24 26	10 00
Other sales ..	—	—	—	12 00
Total output ..	94 38	170 64	106 26	60 00
Surplus ..	34 12	100 15	74 44	29 40

No doubt the cost position has changed somewhat since the 1932 figures were collected, as has the price of steers and surplus cattle. Taking the figures as given for purposes of illustration, however, what can we conclude as to the cost of production of butterfat? We have here another of those joint-cost problems which cause so much trouble in farm accounting. Clearly we cannot take the total costs without making some allowance for live stock sales and increase. Some might feel inclined to deduct the sales other than dairy produce from the total expenses and call the balance the expense of production of butterfat (overheads are not included). This would give results as under:—

	Per Cow	Per lb. Butterfat
	Sh. cts.	*Cents*
Farm No. 21	29 88	42
Farm No. 14	16 85	13
Farm No. 11	7 56	8
Average of 47 Farms	8 60	20

An alternative and perhaps a more logical method is to apportion the costs between the various sources of income. It is practically impossible to say that a given proportion of the total cost is occasioned by raising the cow and milking it, so we may say that each shillings-

worth of output must bear its due proportion of the total cost and allocate the latter in proportion to the value of each joint product. If this is done the expenses of butterfat (on the 90 cents per lb. basis) appear as under:—

	Per Cow	Per lb. Butterfat
	Sh. cts.	*Cents*
Farm No. 21	40 86	58
Farm No. 14	48 35	37
Farm No. 11	24 56	27
Average of 47 Farms	19 38	46

It must be borne in mind that the last figure neglects the value of the increase retained on the farm. It is probable, too, that present-day yields show some improvement on those for 1932.

The extraordinary difference in costs per cow will be noticed. The difference arises chiefly in the expenditure on labour. Farm 11 is managed with great care, and a certain amount of labour probably appears in the item "Miscellaneous", which is in part composed of a share of farm expenses not directly allocated to any department of the farm. Farm 14 is run on very intensive lines and the high labour cost per cow is more than covered by its high productivity. Farm 21 presents a contrast to the usual rule that costs per cow are lower with larger herds than with small.

It would be somewhat hazardous to try to construct a typical set of figures for dairy farms in the Colony from the above. It is evident from census returns that the yields on farm 21, 14 and 11 are well above the average for the Colony. Even neglecting the drier ranching areas where dairy production is subservient to cattle-raising, it scarcely seems probable that the average yield per cow exceeds 60 lb. per year. In view of the fairly close similarity between the costs of farm 11 and the average of the forty-seven farms, we might perhaps take this example for purposes of illustration, but substitute 60 lb. of butterfat for the 91 lb. actually recorded. The results may then be summarized thus with butterfat priced at 90 cents per lb.:—

	Per Cow
	Sh. cts.
Expenses	31 82
Credits	78 26
Surplus .. *Sh.*	46 44

If we can conclude that such a result is at all typical, an observation of some significance arises from it. Ordinary grade cows seem to sell nowadays at from £6 to £10 per head, and even more. On the above results the period required to liquidate a first cost of £8 would be nearly $3\frac{1}{2}$ years. The costs considered, however, do not include cost of land, management or living expenses, interest or depreciation on equipment. The illustration applies, therefore, only to farms which are already going concerns with the items mentioned already fully provided for.

The case with a new dairy farm is different. To illustrate such a case let it be supposed that the land costs £1 per acre, six acres are required to carry a cow and followers, the interest rate is $6\frac{1}{2}$ per cent, £150 per annum is to be allowed for management of a 250-cow dairy, and Sh. 3 per cow per annum is an appropriate provision for amortization on equipment. These overhead charges would then work out as follows:—

	Per Cow Per Year
	Sh. cts.
Interest on Land Cost	7 80
Interest on Cost of Cow	10 40
Management	20 00
Amortization of Equipment	3 00
Sh.	41 20

The net profit per cow would then reduce to Sh. 5/24 and the period required to liquidate the cost of the cow would be over thirty years.

This example should of course be regarded as an illustration and not as a proof. In the example taken the retained increase was valued at £5 per head for cows instead of £8 and the figures would be improved if the £8 value were taken. This improvement would gather momentum from year to year by geometrical progression. It might be possible to value butterfat higher than 90 cents per lb. at the present day and something should be allowed for the value of separated milk fed to pigs. The reader may make such adjustments as seem appropriate, but on the other side the risks of disease, breeding troubles, droughts and locusts should not be forgotten.

On the assumptions as regards overheads, and with butterfat at 90 cents per lb., farm 14 would make a better showing. The period of liquidation would be less than three years. On farm 21, however, the net profit would be wiped out altogether.

No doubt in the circumstances of this Colony the most common case is that where additional cattle are acquired for an existing herd. Land cost and management are already provided for in this case and only interest on the cost of the animal and amortization on equipment need be considered in deciding what an animal is worth. In other cases it may be desired to change over from an unprofitable crop to dairy farming and then it would be necessary to make some allowance for living costs, and perhaps for interest on land mortgage.

The "marginal" principle also comes into play. When additional cattle are added to an existing herd the "marginal" cost of each additional animal is lower, as costs do not rise in proportion to additions to the herd. The above calculations, with appropriate modifications, may serve a double purpose. They indicate the basis on which credit can safely be extended to farmers in different circumstances on chattel mortgage arrangements, and they lead to some estimate as to the overheads which a dairy farming proposition can carry. Naturally, a continuance of the same price conditions is an inherent assumption where a particular set of figures is used to illustrate a case.

Fortunately, during recent years it has been possible to pick up low-grade and native animals at much more favourable prices. They have proved to be a mixture of good and bad, of course, but there is no guarantee that such will not be the case with higher-priced mobs. Yields from low-grade herds sometimes compare well with the average run of herds in the Colony. The following particulars (relating to farm No. 21) may be cited in illustration. A herd of cows and heifers was got together in 1931 at an average figure of slightly under £3 per head. No other cattle except bulls have been purchased and in fact forty to fifty of the original purchases died *en route* to the farm or before being fully acclimatized. The herd had increased by 43 per cent (all ages) by the beginning of 1935, since when the stock record has been as follows, on a basis of per 100 cows:—

	Purchases	Births	Deaths	Sales	Increase on hand	Net increase
1935	2	94	25	10	61	69
1936	4	96	60	29	11	36
1937	—	95	45	22	28	50

As will be seen from Table VI the average yield was 71 lb. of butterfat (year 1937).

It is not suggested that purchase of animals of native type is necessarily preferable. The data do not provide a sufficient basis for any such comparison. Comparison of results for a sufficient number of herds might indicate that the lower cost of native animals is fully offset by their lower productivity and the lower value of surplus animals sold.

How to make a Light Ladder

By ARTHUR W. BARNLEY, *Kiriga Estate, Thika, Kenya Colony*

As a rule the ladders used in the country districts are made of wattle poles or other heavy native timber and, if of a considerable length, are so heavy that one man cannot handle them.

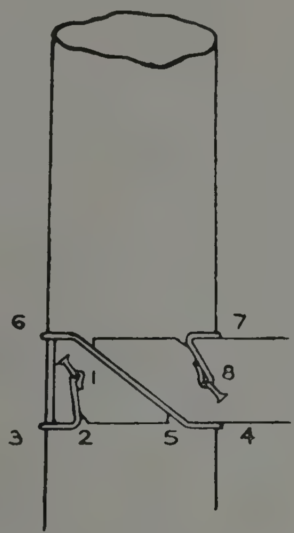
A good light ladder has been made of two sisal poles. The strength of the poles was not reduced by notching or cutting and by this method the poles were saved from the early rotting that would have taken place had there been any openings in their outer skin.

The following treats of a ladder 15 ft. long and 2 ft. 6 in. wide at the top. The diameter of the poles is 4 in. at the foot and 2 in. at the top. With a little trouble in selection of the poles a safe ladder considerably longer could be made.

Very straight, dry, sound poles should be chosen, they should be cleaned smooth and given two coats of paint. As much paint as possible should be worked into the end grain at both ends, making the poles as waterproof as possible.

The rungs are wrapped tightly on to the poles with No. 14 wire and it is this wrapping, the friction between the fitting surfaces of pole and rung, the taper of the poles, and the more than usual slope of the poles toward each other which keep the rungs in position. A heavy man jumping on the rungs will not move them down appreciably and the greater the weight put on them, the tighter they will become.

The rungs are made of 2 in. × 1 in. sawn timber. Podo answers well enough but if extra tightness is sought, deal should be used. Grooves of the same radius as the poles are worked in the 2 in. side of the rung and should be a little less than $\frac{1}{2}$ in. deep and the fit to the pole should be made as accurately as possible. Nicks are cut in the corners of the rungs for the wire to lie in.



The wire begins at a 1 in. nail (1), is taken through a nick (2), round the pole, to a nick (5), across the face of the rung, then again round the pole and it finishes on a 1 in. nail (8). Both nails and the ends of the wire are knocked down flush into the timber. Nail (1) should be knocked down at the start and if the wire is pulled well with a pair of pliers while wrapping, it will come tight enough.

To increase the friction between rung and pole, the groove should have a coat of paint. The ladder should be used with the rungs outward.

The advantages of this ladder must be paid for by hanging it up in a dry place when not in use, and to prevent deterioration of the ends of the poles, they should be cleaned every now and then and given a coat of paint. It is worth while, though rather difficult, to protect the ends of the poles with sheet iron caps and these should fit closely and should be primed with thick paint to prevent water getting into them.

The Conservation of Green Fodders for the Dry-Season Feeding of Stock

By M. H. FRENCH, *M.A., Ph.D., Veterinary Department, Tanganyika Territory*

The majority of live stock in Tanganyika Territory subsist on a diet which is characterized by alternate periods of abundant grazing and of food shortage. The shortage at the end of the dry season in certain localities may even become so acute that famine and starvation prevail. Amongst the native-owned herds, whose extensive grazings are limited only by local traditions, tribal rules, and watering facilities, this unsatisfactory nutritional state is more prevalent than amongst the animals confined to European-owned farms, though these latter are by no means free from seasonal variations. Whether one is considering native-owned zebus or high grade European-owned animals, the necessity is everywhere apparent for conserving the excess of grazing available in the rainy season for use during the dry. Every year thousands of acres of valuable grazing are lost to the live stock industry because they are allowed to dry off and lose their feeding value before animals get access to them, whilst thousands of other acres are lost in the smoke of bush fires. This wastage of stock food occurs annually, yet the preservation of fodder for "winter" feeding is met with all too rarely on the farms and hardly at all in the native communities.

The art of conserving green grass in a form suitable for "winter" feeding originated when our forefathers were forced, by the increasing human and stock populations, to abandon the system of communal grazing and to maintain their animals on the products of their own plots of land. Whilst it is surprising and disappointing to find so little fodder conservation by European farmers in Tanganyika, it is hardly to be expected that the native would have adopted fodder conservation as an established husbandry practice because he has not yet reached the stage of economic evolution which prompted our own forefathers to develop this art.

Because it is essential that all information possible on this problem of fodder conservation under East African conditions should be available against the time when the native will be ready to make use of it, and because European farmers are in immediate need of such information, a certain amount of work on this problem has been done at Mpwapwa. It is often argued that since civilized countries took so long to develop fodder conservation to its present standard, the African native will also take a long time to understand and become accustomed to its inclusion in husbandry practices, but if its principles are already established its adoption will be the more speedy.

In this Territory native husbandry varies considerably, from that of the nomadic Masai, through that of the pastoral agriculturalists (such as the Wasukuma), to the intensive methods of the Wakara and Wachagga. The nomadic Masai follow the most primitive of all our systems—they drive their animals to graze wherever there is a sufficiency of food and water, keeping however within the area over which they have by tradition acquired grazing rights.

The pastoral agriculturalists graze their stock communally on the restricted grazing grounds around and amongst their cultivated areas. The Wakara and Wachagga have become much more intensive in their methods because land is at such

a premium and there is no room for extensive grazing. In Ukara the animals get a limited amount of grazing supplemented by stall-feeding, but in some areas the Wachagga keep their animals from birth inside the family hut and carry in food from a distance. It is thus obvious that where there is a sufficient economic urge the native will stall-feed his animals, restrict their numbers to a minimum and conserve the crop residues from his fields. In Ukara it is no uncommon sight to see maize or millet stalks stacked in the forks of trees or on the tops of rock outcrops to guard them against the ravages of white ants and conserve them for the stall-feeding of cattle. Since in these instances the African has evolved intensive methods for himself, it is reasonable to believe that demonstration and education will encourage the adoption of fodder conservation in areas where this is not yet considered necessary by the local tribes.

For the native communities there are three main methods by which grazing can be conserved for winter feeding, namely: (1) rotational grazing, (2) the making of hay, and (3) the making of silage.

Rotational Grazing

This term includes many types of pasture management, all with the principle of replacing the uncontrolled continuous grazing of a large area by the controlled alternate grazing of sections. This is already practised in an incomplete form by the pastoral and pastoral-agricultural tribes, who set aside certain areas for dry-season grazing only. Grass is thus allowed to grow, mature, and die in situ and no labour is involved in making or collecting the hay. Stock are then turned in to gather this sun-dried grass for themselves. Of the three systems of conservation to be considered here, this one involves the greatest waste, because many nutrients pass from the leaves into the seeds which are then scattered and lost to the animal; some leaves are broken off and carried away by the wind; and the stock trample, soil, and render unfit for consumption still more.

It is one object of the Tanganyika Veterinary Department to encourage the organized and complete transference of cattle by pastoral tribes away from the permanent water-holes during the rainy season. The object is to graze those areas further away on which the stock can get an adequate supply of water from surface rain-ponds in the wet season and then, as the grazings are eaten out and the surface ponds dry up, the stock move back on to the areas surrounding the permanent waters. So long as the stock movement is complete and no defaulters are left behind, this system of rotational grazing is the simplest way of increasing the stock foods available for the pastoral tribes. It is also the least efficient method, but it has the great advantage of not needing any extra labour on the part of the stock owners. Because of its simplicity and the obviousness of its results this method is the first that should be introduced into any area. Only when the natives have learnt the advantages of this method of fodder conservation will it be advisable to introduce the more efficient methods of preservation which require a certain amount of labour for their success. The natural tendency of the natives is to do as little work as possible in the growing and reaping of their own food crops; it will be some time before they can be educated to work at conserving food for their animals which, in the native's opinion, are well able to collect their food themselves.

Haymaking

To cut green grass and allow its moisture to dry by the sun's heat, aided

by warm breezes, is the next step forward. By cutting the green grass the quality of the final product is more capable of control because the grass can be cut before valuable nutrients are withdrawn from the leaves into the seeds, and also, when it is dry, the cut hay can be carted away and stacked so that loss of quality owing to leaching by rain and dew is prevented. Cutting grass and drying it in the sun sounds a most simple procedure but hay is the foodstuff which varies more in quality than any other on the farm. The production of good hay requires, amongst other things: (*a*) the right type of grass or mixture of grasses, (*b*) cutting the grass at the correct stage of maturity, and (*c*) the curing into hay with a minimum amount of handling and of exposure to the sun, dew and rain.

Experience has shown that a good type of hay can be prepared from mixtures of our local grasses, and that hay from perennial mixtures is superior to that from annual grasses. It has also been proved that better quality hay is made if the grasses are cut half way through the wet season, when they have just reached the flowering stage, than at the beginning of the dry season when they will have seeded. Moreover, the cutting of grass in the middle of the rains allows a further good growth to develop and this can either be grazed during the dry season or made into aftermath hay. Aftermath has a better composition than hay made from the whole season's growth. By cutting in the middle of the rainy season there is an improvement in the quality of the product but there is always the risk that part of the first crop of hay may be spoilt by rain. Because of this risk it is often asked why the grass could not be left until the dry season. Previous work (French, An. Rept. Dept. Vet. Sci., Tanganyika, 1933, p. 58) has shown how the composition and feeding value of our local grasses fall off with increasing maturity. In the tables figures are given showing the nature of these changes in the composition of one of our best grazing grasses as the season advances and the grass matures. Data are also given showing how the composition and feeding values vary between hays made from the same field at different seasons.

In Table I are given the compositions of samples of green grass (*Cynodon plectostachyum*) taken at monthly intervals from adjoining plots. The figures in the first half of the table represent the compositions of grass which had been uncut since the beginning of the season, whilst the data in the second part of the table refer to grass which had been cut at monthly intervals.

TABLE I

COMPOSITION OF *Cynodon plectostachyum* (DRY MATTER BASIS)

	SEASON'S GROWTH						GROWTH DURING EACH INDIVIDUAL MONTH				
	13th Jan.	10th Feb.	9th March	6th April	4th May	8th June	13th Jan.	10th Feb.	9th March	6th April	8th May
Crude Protein	15·78	11·39	10·06	10·09	8·07	7·19	15·78	15·74	12·85	12·01	15·63
True Protein	12·78	8·82	8·16	8·15	6·69	5·78	12·78	12·71	10·30	9·32	12·88
"Amides"	3·00	2·57	1·90	1·94	1·38	1·41	3·00	3·03	2·55	2·69	2·75
Ether Extract	3·27	2·82	2·87	2·21	1·97	1·86	3·27	2·85	3·09	3·64	3·78
N-free Extract	40·74	43·09	42·66	42·46	42·88	42·87	40·74	41·45	42·44	39·31	37·99
Crude Fibre	28·88	34·01	35·78	36·72	39·02	39·51	28·88	30·02	32·15	34·78	30·89
Total Ash	11·33	8·69	8·63	8·52	8·06	8·57	11·33	9·94	9·47	10·26	11·71
SiO_2	4·54	4·32	4·86	3·96	4·10	4·00	4·54	5·11	5·58	5·30	4·83
SiO_2-free Ash	6·79	4·37	3·77	4·56	3·96	4·57	6·79	4·83	3·89	4·96	6·88
CaO	1·037	0·960	0·930	0·760	0·722	0·701	1·037	1·038	0·928	0·953	1·066
P_2O_5	1·063	0·709	0·592	0·634	0·649	0·602	1·063	0·909	0·795	0·837	0·941
K_2O	2·285	1·875	1·650	1·658	1·630	1·581	2·285	1·895	1·850	1·891	1·952
Na_2O	0·411	0·262	0·220	0·190	0·160	0·160	0·411	0·315	0·270	0·269	0·300

TABLE II

COMPOSITIONS, DIGESTIBLE NUTRIENTS, AND STARCH EQUIVALENT VALUES OF HAYS MADE AT DIFFERENT TIMES OF THE YEAR

TYPE OF HAY ..	FIRST CUT HAY		AFTERMATH HAY		HAY CUT AT END OF RAINS		HAY CUT IN MIDDLE OF DRY SEASON	
AGE WHEN CUT ..	6 WEEKS		16 WEEKS		22 WEEKS		38 WEEKS	
	Composition	Digestible Nutrients	Composition	Digestible Nutrients	Composition	Digestible Nutrients	Composition	Digestible Nutrients
Crude Protein ..	10·48	6·13	8·00	3·73	7·33	3·75	5·18	1·19
Ether Extract ..	1·60	0·28	3·65	2·44	1·04	0·10	0·92	0·21
N-free Extract ..	46·34	28·04	45·03	22·04	45·86	21·67	46·05	23·67
Crude Fibre ..	31·40	19·68	33·35	18·29	37·09	19·88	39·72	15·86
Total Ash	10·18	—	9·97	—	8·68	—	8·13	—
Organic Matter ..	89·82	54·13	90·03	46·50	91·32	45·40	91·87	40·93
Starch Equivalent..	—	35·80	—	29·02	—	23·75	—	19·75
Nutritive Ratio ..	—	1 : 8	—	1 : 12	—	1 : 11	—	1 : 34

The first impression gained from Table I is the good quality of this grass (which had been grown on good soil). The figures show how fibrous our local grasses are, even after one month's growth. The variations in protein, fibre, ether extract, and ash with increasing maturity are similar to those recorded in other parts of the world.

In Table II are set out the compositions and digestible nutrients of hays from the same field but cut at different times during the same season.

These figures illustrate how much poorer in feeding value hay made at the end of the wet season is than that made after six or nine weeks' growth. The sample of aftermath hay is intermediate in composition and feeding value between first cut hay and hay from the whole wet season's growth of grass. This particular aftermath hay was poorer than usual in digestible protein (*see* French, An. Rept. Dept. Vet. Sci., Tanganyika, 1934, p. 54), but these figures show clearly that any attempt to make hay in the wet season is justified.

In this same table are given the composition and digestible nutrients of grass from the same field which was not cut at the end of the rains but was allowed to mature and dry off in situ. This crop represents the product which would be produced under the rotational grazing system, but under that system the stock would trample and soil a certain percentage of the crop whilst the more brittle leaves would be broken off. Cutting the crop as in this experiment probably gives higher figures for the digestible nutrients than would be given by the grass actually consumed by animals turned in to graze this mature grass in August.

Under our local dry-season conditions cattle live very largely on dried fodder, similar to this sample under experiment, supplemented with dried leaves and the residues and weeds from the grain fields. From the middle of June stock under these conditions cease to make any live-weight gain and by the middle of July are actually losing weight. The rate of loss of weight then slowly increases until the end of October and thereafter live weights fall more rapidly until green grass becomes available after the first rains.

It can be calculated from the figures in Table II that the amount of fodder which at present suffices to carry cattle from mid-June until the end of October would, if gathered and stacked as hay at the end of the wet season, carry this same number of cattle over till the end of

November with only the same live-weight loss as that now occurring by the end of October. Since most weight is lost during the last month of the dry season and the first few weeks of the next rainy season it is obvious that haymaking would do much to minimize weight losses and allow the cattle to reach maturity much sooner.

Silage

Ensilage is a method of preserving green crops in a succulent form, for winter feeding of stock, which has made tremendous strides in the last fifty years. The advantages of succulent, green, vitamin-containing foods in the height of the dry season need no labouring, whilst many regard silage as an essential constituent of dairy rations at this time of the year. Ensilage in Tanganyika is usually regarded as a method for European farmers, but there is no reason why natives should not make a very good quality product from the ensilage of green grass in pits or clamps. No capital outlay would be required, but a certain amount of work is needed. Many regard the growing of specialized crops, such as maize or sunflowers, as a necessary corollary to good silage production, or else they associate silage with the saving of grass which has been completely ruined by rain for hay production purposes. Almost any green crop can be ensiled and in this Territory grass is the most obvious crop; expensive arable crops are not necessary. Grass silage can be a product of high feeding value. Although it has been shown (French, An. Rept. Dept. Vet. Sci., Tanganyika, 1932, p. 62) that grass which had been washed badly by rain could still yield a silage having a feeding value equal to hay from the same crop (weight for weight of dry matter), usually the better the quality of the grass ensiled the better the quality of the resulting silage.

As well as being a means of conserving the first growth of green grass, silage can be made from many of the taller grasses which are less valuable for grazing. I have given elsewhere (An. Rept. Dept. Vet. Sci., Tanganyika, 1933, p. 54) the composition and feeding values of *Panicum maximum* silage, and there is no doubt that this and other species of tall grasses could be used successfully as a silage crop.

From the native point of view silage is likely to be the least important of the three methods of fodder conservation under review. It is also unlikely that the native would contemplate its use until he has been educated in, and has proved for himself, the value of the two more simple procedures.

Summary

There are three main methods of fodder conservation open to natives as well as to European farmers in Tanganyika. The European settler could use any of these methods but the native still has to be educated to them. A simple system of rotational grazing properly organized and controlled is the first method which should be encouraged in native communities. This system conserves the fodder in situ without labour, but it is wasteful of valuable nutrients. Once the value of this method has been proved to a native community, haymaking should be encouraged. The third method of fodder conservation, the making of silage, will not be introduced successfully into native husbandry until the native has been educated to appreciate quality not only in his animals but in their products.

Agricultural Surveys in the Eastern Province, Uganda

By T. R. Hayes, *M.Sc.* (*Manchester*), *A.I.C.T.A.*, *Agricultural Officer, Uganda*

During the last five years, agricultural officers have been engaged in conducting detailed surveys of small administrative units called *mitala** (singular *mutala*). The primary object is to ascertain the position in regard to soil deterioration in the various agricultural areas, and to determine the size of small holding required by a family in order to grow all its food and cash crops, support live stock, and yet maintain the fertility of the land.

The first surveys were necessarily of a tentative nature, and a short account of the first essays has been published in this Journal. [1] From the experience gained in these, the Agricultural Survey Committee framed a standardized questionnaire, which introduced a large measure of uniformity into the subsequent reports, and ensured that nothing of importance was omitted. The committee consists of senior members of various technical departments under the chairmanship of the Director of Agriculture, and the scope of the surveys was widened to include a larger field of subjects, such as diet, social organization and crafts, the continued study of which is of vital importance for the wise government of the people. At the same time, the surveying officer was encouraged to investigate any additional subjects that he considered to be of interest or importance, without qualification, with the result that the surveys were not reduced to a dull routine, but individual interest was maintained at a high pitch.

The method of approach adopted by the writer is that the people selected should be studied as a group of human beings, rather than as a collection of scientific specimens. The latter method of approach is likely to lead to abortive results, as nothing is more likely to provoke resentment, and the goodwill of the people is essential. This argument is expressed better than I can put it in the following extract. [2] "It is important that every . . . officer, *inter alia*, should understand the African and especially that he should learn to appreciate the changing African. We must realize that the penetration of European civilization has come to him as a revolution, as a fundamental disturbance, which has deprived him of his natural balance and created for the time being situations which may appear to the European strange, contradictory or repellent. If we are not to succumb to these impressions, and if we are to find a clear line for our actions, one thing above all is needful: a real objective scientific knowledge of the actual conditions, their inter-relation and their interpretation . . . It would be better, even for our own practical purposes, to take time to study the African as he is and start our work on him from his standpoint instead of our own."

Technique of Conducting Surveys

A report of the nineteen surveys already carried out has recently been published by the Agricultural Department, together with the text of fifteen of the surveys, [3] and there is no point in attempting further to summarize in this article the mass of information contained there. It may, however, be of interest to discuss the

*The Luganda word *mutala* means a small hill or ridge which is usually bounded by swampy land or water and commonly encountered in the undulating country of Buganda. It was used in this sense in Mr. Haig's article in the May *Journal*. By reason of their topography such *mitala* (plural) often form a convenient unit for administrative purposes and by usage the word *mutala* has been extended to cover the small administrative unit as well.

actual technique of conducting the surveys.

Choice of Area

The following criteria are useful in determining where the survey is to be carried out.

(*a*) The *mutala* should be typical of a fairly considerable area, and should not be too near such influences as towns, missions, or demonstration farms, unless the study of such influences is the special object of the survey.

(*b*) The area should possess a good and reliable chief who, from detailed knowledge of the area, can assist in checking information.

(*c*) The inhabitants should not have been the recent subject of any disturbing influence, such as clan quarrels regarding land, otherwise strong suspicion of the survey is likely and no good results will be forthcoming.

(*d*) The area and number of people should not be of unmanageable size, otherwise the officer will find that too much time is taken up with mere measuring. An area of one square mile and a total population of 500, will give rise to a fortnight or three weeks' field work. Furthermore, the concentration on a huge mass of detailed statistics may tend to divert the officer's attention from the other important lines of investigation.

(*e*) The area should be convenient to get at, while bearing in mind section (*a*) above. There should be a rest house very near, or a tent pitched in the area. A series of day visits by car will never achieve the same results; only the dry bones of the survey will be obtained.

(*f*) The *mutala* should be as self-contained as possible and with definite boundaries. Where the inhabitants use land outside the *mutala*, or other people cultivate in it, it is difficult to apply the statistics to the *mutala*, considered as a unit. With regard to boundaries, an extreme case can be found on Mount Elgon, where the *mitala* areas may stretch from the inhabited part to the top of the mountain, over several miles of forest, heather and barren parts.

Checking of Information

The actual figures required can be obtained with any desired degree of accuracy by personal measurement or counting. Nothing should be taken for granted. For instance, if a man is asked how many children he has, he may easily give the number who have been born, some of whom have died or emigrated. The children must be seen.

With regard to more general matters, one has to rely to some extent on what the people say. The unreliability of such information has often been mentioned by experienced investigators. Various reasons have been put forward to account for lying. One is fear of the consequences of truth. Another is that knowledge is worth something, and if the truth is told, something has been given for nothing; therefore tell a lie. A third reason is the desire to please, and the investigator is told what it is thought he would like to hear.

These influences are countered as follows. The question is first put in this way. "Do you like eating (*e.g.*) mushrooms?" The answer is "yes". After more questions one returns to the first question and says: "You don't like mushrooms, do you?" If the desire-to-please motive is there, the answer may be in the negative, and one is warned. This of course means that much interesting information may have been discarded on the grounds of unreliability, but it is better thus than to publish rubbish. If the chief is really reliable he can often warn the officer against doubtful answers. Another check is to ask two people the same question. Thus if A says he was sick for three

months last year, he may be exaggerating in the hope of being excused poll tax; on the other hand he might think this would not work, and wish to minimize his illness on account manly pride. But his neighbour B is not influenced by these matters, and a question to him is a valuable check.

Preliminary Survey

In his ordinary affairs the Agricultural Officer usually works at a certain pressure, and office routine statistics have to be handled with dispatch, with a more or less efficient educated clerk to assist. In a *mutala* survey all this is changed; endless patience is required, the question may have to be put in several different ways before it is understood and answered correctly, and a gradual approach made where a question is likely to frighten or antagonize the informant. The average African outside his own home does not give a true picture of his kind, as it is often the more adventurous and virile who go out into the world. But in a *mutala* survey one may find a population that has not been subjected to this selection, and some of the people, through sickness, ignorance or heredity, show a duller mentality, and this may tax the investigator's patience. It is therefore a wise move to spend a little while taking a pleasant walk round the area, so that the mind can become attuned to the slow motion of village life. More important still, the people will get to know the officer personally before he starts to subject them to endless questioning. From the point of view of the work this time may be very well spent. For instance, if the officer starts his verbal investigation straight away, he may spend much time questioning every person regarding the distance they have to go for water. If he took a preliminary walk round he might find that there is only one waterhole in the whole area, and the average distance can be easily calculated from the plan.

The Questionnaire

1—*Description of Area*

The topography of the *mutala* is described, in general terms, going into detail where this is necessary for the proper understanding of the subsequent argument. An account of the vegetation and soil is given, and a brief description of the type of people and surrounding country.

2—*Total Acreage of Cultivable Land*

It is usually best to obtain the accurate area of the whole *mutala*, and then subtract from this the area of rocky hills, swamps, etc. The area of the *mutala* can be obtained by chaining the boundary with a compass, by triangulation or by a base line with offsets. These methods have their several disadvantages, the last two requiring an excessive amount of clearing for sights to be taken. The best method has been found to be plane-tabling; a careful African assistant can be quickly taught the method, and if the points are pricked off as they are reached, or an HH pencil insisted on, any error is self-evident at the end and no "cooking" of results is possible. This releases the investigator from several days of routine work, and enables him to devote his whole time to those parts of the survey that require personal supervision to ensure accuracy.

3 (*a*)—*Total Acreage under Cultivation at any one time*

Every plot under cultivation is measured and entered under the owner's name. To measure plots of differing shapes with instruments would take an inordinate amount of time, and the method used is to pace out the average length and breadth of each plot, and assume that it is a square. Four assistants can be used, two men on each side of the officer measure the length and

breadth respectively of two plots, while the officer enters the figures called out to him. The Chief is by his side and tells him the name of the owner. If possible the owner is also there and gives information regarding previous crops. As soon as everyone knows his job, the work proceeds quickly, and a hundred plots can easily be measured in a morning.

3 (*b*)—*Total Acreage of Cultivable Land Resting at any one time*

It is impossible to measure this directly by simple methods. The resting ground generally supports high grass, and in the mass may have an extremely irregular shape, with indentations of cultivation. Its acreage is generally obtained by subtracting the area of land under cultivation from the total cultivable area.

3 (*c*)—*Total Area under Forest or Suitable for Forest*

This includes non-agricultural land such as hill tops, rocky outcrops, semi-swamps, etc. These have mostly already been measured to arrive at the figure required under 3 (*a*). Any dense area of forest is measured by plane-tabling round it. Apart from actual forest, which may also be agricultural land, the principle followed is that "forestry begins where agriculture ends". Where an officer has specialized knowledge of tree species there is scope here for the accumulation of additional information regarding number and density of species, ecology and the effect of man on the forest.

4—*Population*

It is necessary to record the total number of taxpayers, families, adult males, females and children; also the number of working units per family. The latter is obtained by counting an able-bodied man as one unit, an old man or a half-grown child as half a unit, a woman as half to one unit according to the discretion of the investigator. No hard and fast rule can be laid down in this matter. Much depends on tribal custom; a woman may be regarded as doing at the very least as much agricultural work as the lord and master of the family; or else by reason of child-birth, household duties, etc., she may be regarded as doing considerably less.

Under the heading of population also come the occupation of adults, and average incomes. In the Eastern Province farming is very predominantly the occupation, and even where people have other occupations such as those of schoolmaster, tailor, rough carpenter, mat maker, labourer, blacksmith, chief, it is found that their roots are still in the land, their professions are often additional occupations, and in the event of lack of custom or dismissal, they easily revert to full-time agriculture. This is admirable in its way, and in the event of a depression there is little fear of the evolution of an unemployed and eventually unemployable class, ready for trouble. A corollary to this, however, is that in the employment of junior grades of Africans there is little fear of dismissal, which is reflected in the standard of their efforts.

A further question under the heading of population is the average income of individuals of different occupations. This is very difficult to ascertain. It is in the first place liable to arouse resentment in the belief that the Government is going to increase taxes. It is furthermore very difficult to check the information given. Also it is a subject especially prone to false information, the African in the Eastern Province being rather secretive about his possessions. The reason is either that he is still in a communal state and would be forced by public opinion to share his wealth, or else fear of robbery. Where the information can be obtained, it is of great value for economic studies.

5—*Live Stock*

The numbers of each sex are recorded and presented as an average per tax payer and per family unit. Then an account is given of live stock management, feeding, housing, etc. Where the cattle are habitually grazed in the *mutala,* it is possible to get the valuable figure of how many acres of uncontrolled grazing are required per head of cattle. While large areas of otherwise useless swamp land are often found to provide an admirable reserve of grazing during the dry season, it is evident from the surveys to date that to make provision for the calculated increase of people and their cattle in fifty years' time will be quite impossible. In the Ajaluku survey in Teso District, where over population exists, there are under three head of cattle per taxpayer, which cannot be considered excessive, yet these numbers will have to be reduced or else a more intensive system of grazing evolved to support the present numbers. Experiments have been started to solve this problem, but it is already evident that any information from the *mitala* surveys is of great assistance in framing policy.

6—*Details of Cultivation*

The systems of rotations followed are required, and these can be obtained in two ways, of which the first is by asking each owner the history of his plots, including the period of fallow. A surprisingly good memory is often shown, but to avoid errors it is better to record merely the previous crop. This can often be checked by the crop debris still lying on the ground. The results are then expressed as the percentage of various crops on new land, and following cotton, *Eleusine,* etc. It then only remains to find out the total periods of fallow and cultivation, where the memory of the informant must be relied on.

Hired labour is not an important item in the Eastern Province; on the contrary, many people go elsewhere to work as porters. This is of course of great importance, and details can be collected of average period and time of year usually absent, effect on social life, etc.

7—*Social Life*

(*a*) *Constitution of* Mutala *and whether on communal or individual basis.*—This is where measurement ceases to be of use, and ability to study the human element comes in. A knowledge of the local language would be of enormous value, but in addition to Kiswahili and Luganda as *lingua franca,* there are nine other languages in the Eastern Province, and it is obviously impossible to learn any proportion of these. Many missionaries by reason of continuity in one place become experts in one local language and tribe, and often an insight into the mentality of the people can be obtained from them.

A good deal can be learnt on the communal question by examining the conception of individual property; for example, whether boundaries of plots are clearly defined and strictly enforced; whether borrowing of land occurs; if there is communal land used for crops like cassava (the planting of which is enforced by Government). Sometimes half-a-dozen people form a club to carry out communal work on each other's land. Inquiries can be made as to whether an owner objects to fire-wood being collected on his *shamba,* whether old people can depend on support from the community, the organization of the clans and the strength of their cohesion, the extent of support given freely to the hereditary leaders.

(*b*) *Diet of people, number and frequency of meals, use of salt and plant ash.* With regard to crops, the diet can be assessed with sufficient accuracy from

the measurements of areas. With regard to wild fruits, fungi, wild animals, much depends on the answers received. The consumption of these, together with meat and fish, depends greatly on season, either for natural causes or because money is available to purchase them only after the sale of cash crops. Therefore the inquiry must extend over the previous twelve months. A check can sometimes be obtained by questioning the local butcher, fish trader, or owner of game net. An amusing illustration of the great care necessary in questioning occurred to me. Africans here, as probably elsewhere, are mainly vegetarians and one man questioned said he ate twenty-eight fowls during the previous month. This man had rather a facetious attitude, and I controlled my annoyance as best I could and was prepared to dismiss the subject. However, patience reasserted itself and on further inquiry I found that his statement was quite true. His fowls died daily from a disease, and he naturally had to eat them! This is an instance too of the common experience that none of the people would have thought of telling me of this important matter, had it not arisen accidentally. Naturally a specific question on fowl diseases was henceforth added to my questionnaire.

(c) *Division of labour*, as between men, women and children, and as between money crops, food crops, herding of live stock, water carrying, etc. Some of these matters are easily answered; for instance in many parts it is *infra dig*. for a man to carry water, or cultivate sweet potatoes, and this fact soon emerges. With regard to other crops, it is generally the man that is questioned, the women remaining modestly in the background. It is therefore the man's version of his share in the work that is obtained. Many of the women are too backward or shy to answer questions properly. Also, unless properly managed, there is a possibility that this might cause offence, especially in a Mohamedan community. If possible, however, some of the more intelligent women should be questioned, and much can be learnt by a general walk round, observing the people at work.

(d) *Domestic water supplies* in the Eastern Province are often very impure, and a good deal of time is taken up in fetching water. Information is required on these points, also about any devices for catching rain-water. The ubiquitous plantain is sometimes used to form collecting gutters.

(e) *Domestic fuel supply*.—This may come from the natural forest, or the savannah tree population may be depleted until in the worst areas there is hardly a tree left standing. This has most serious implications, and all information on the amount of fire wood required, use of grass stalks, and so forth, is of use in framing policy.

(f) *Local industries* such as bark cloth-making, carpentry, pottery, iron work, are studied, and in the somewhat rare cases where they are discovered they afford scope for research according to the taste of the investigator.

(g) *Supply of building poles* and withies, number used and distance carried are reported on; the demand for these is varied, depending on the prevalence of white ants. It is sometimes difficult to arrive at the length of life of a house, as poles may be replaced as they become useless and repairs may be gradually carried out until the structure is practically a new house. As with fuel, a good deal of time may be wasted in foraging for poles. The division of labour is of importance, and here is an example of the value of studying the human element. The women forage for fuel, and the farther away they have to go from home, the greater is the opportunity for them to

forget that a husband exists. This might be a strong inducement for the husband to grow a timber plot! (Acknowledgements to Lt.-Cmdr. Templar, R.N., retd., Divisional Forestry Officer.)

8—*Game*

The questionnaire finishes with a section on game, covering the number of game nets used, whether hunting of wild animals is frequent and organized; the prevalence of guinea fowl and francolins and whether they are harmful; if protection of grain crops is necessary against damage by waxbills and weaver finches; the prevalence of rodents and damage to stored grain, the abundance of fish and use of dried fish. Here a wide field of research is open to the investigator. An Agricultural Officer with a knowledge of birds, for instance, can find out much of value regarding varietal resistance of grains to various birds, and why, so that the long awn, size of seed, or whatever it may be, can be developed by breeding.

ADDITIONAL INFORMATION

In order to make the surveys as comprehensive as possible, and to avoid tying the officer down to a deadening routine (each District Agricultural Officer has one survey to do every year), the investigator is encouraged to add any items of interest that he can discover on his own initiative. This has been mentioned before, but it is referred to again on account of its importance. Sometimes the additional information forms the most interesting part of the survey. The questionnaire itself covers a wider field than pure agriculture, and it is open to the Agricultural Officer to invite the District Medical Officer, Commissioner, Forestry Officer, and so forth, to co-operate. One such example of team work between an Agricultural Officer,doctor and statistician has already been published. [4] It is left to the discretion of the Agricultural Officer, as the primary investigator, whether or when he brings in other Europeans. If the people are suspicious, but finally accept the Agricultural Officer after due acquaintance, it will probably be wiser to finish the main part of the survey before risking the incursion of another European strange to the people of the *mutala*. Accounts have been volunteered on such subjects as rural housing and sanitation (in co-operation with a sanitary inspector), economics of tobacco production (in an area where tobacco is a cash crop), migration and the reasons therefor (in an area where the men do not emigrate to work as porters), and the history of a native clan with the political implications thereof (undertaken at the request of the District Commissioner, who was considering making some changes in Chiefs).

CONCLUSION

It may finally be said that in these days of rapid motor transport, and developed agricultural organization with a trained African staff, these surveys afford a salutory method of keeping the Agricultural Officer in direct and intimate touch with the agriculture and people of his district. More is learnt of these vital subjects in the two or three weeks of a survey than in months of ordinary touring, and to all those with an inquiring turn of mind the opportunity is given for a most fascinating study.

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The Sunflower (*Helianthus annuus*)

By L. A. ELMER, *Assistant Agricultural Officer, Department of Agriculture, Kenya Colony*

The sunflower is an annual belonging to the family *Compositae*. Under favourable conditions the plant will grow to a height of 10 feet and the disc-shaped heads may reach a diameter of 2 feet. It is believed to be a native of the great plains of North America from Nebraska to Northern Mexico. The sunflower has been established in Europe and Asia for so long that it is possible it was introduced by Japanese or Chinese merchants from the western coast of America and reached Europe before the potato, tobacco and other American plants. The nutty flavour of the seeds was relished from the earliest times and from Central Europe to the China coast vast quantities are eaten raw to this day.

There are four principal varieties of sunflower that are cultivated for seed, viz. striped or grey, white-seeded, small-seeded black Russian and large-seeded black Russian. The highest yields per acre are generally obtained with small-seeded black Russian and the lowest with white-seeded. The weight per bushel of the seed ranges from about 32 lb. for white-seeded to 40 lb. for small-seeded black Russian. The latter is the best oil yielder. Hungarian grown seed yields more oil than Russian seed.

The main use of the seed is for the production of oil and the resulting cake, which is used for cattle feed. Smaller quantities are used for bird-seed but imports for this purpose are relatively insignificant. In the United Kingdom it is probable that the amount does not exceed 100 to 200 tons a year. For sale as bird seed it should be plump and as large as possible; the lighter colours are more saleable than the black. The value as bird-seed is usually £4 to £5 a ton more than oil-crushers are willing to pay, but only small lots of from 10 tons to 25 tons of picked seed are likely to fetch such prices. The market is easily depressed. Any lots of seed not up to a high standard at once fall into the crushing grade and have to compete with linseed, cotton seed and groundnuts. Crushers prefer lots of 250 tons and upwards at a price ranging from £5 to £6 a ton c.i.f. European ports.

COMPOSITION OF THE SEEDS

The composition of the seeds and kernels is shown in the following table (Wiley, Bulletin No. 60, 1901, Division of Chemistry, United States Department of Agriculture):—

	Seeds	Kernels
	Per cent	*Per cent*
Moisture	4·43	4·89
Fat	27·08	45·21
Crude Proteins	14·97	26·85
Carbohydrates	20·94	16·06
Crude Fibre	29·17	2·67
Ash	3·41	4·32

The above analysis cannot be taken as a standard for all varieties, but the composition of the seed generally does not range far from the figures given.

The seeds usually consist of about equal proportions of seed coat and kernel. The seed coats or husks, being tough, fibrous and rather absorbent, should be removed before expressing the oil.

SUNFLOWER SEED OIL

The manufacture of sunflower seed oil and the resulting oil-cake is practically confined to Russia and Central Europe; small quantities of oil cake are manufactured in Hull. For oil expression the seed should contain a minimum of 26 per cent

of oil and the small-seeded black Russian yields the best. Black or striped seed is almost always used for oil expression. The difference in colour does not amount to much as the residue, after crushing, is usually sold in meal form, but a light-coloured seed might be preferable as it would make the meal a better mixer. The yield of oil obtained from the seed by pressing amounts on an average to about 22 per cent from undecorticated seed and about 38 per cent from decorticated.

Sunflower oil has the following constants, which are shown in comparison with linseed oil:—

	Sunflower Seed Oil	Linseed Oil
Specific Gravity at 15°C.	0·924–0·926	0·931–0·937
Saponification Value ..	188–194	190–195
Iodine Value, Per Cent ..	120–135	170–194

There are two grades of the oil used in commerce, cold pressed and hot pressed. Cold pressed oil from seed of good quality is pale yellow in colour and almost tasteless. It is suitable for use in the manufacture of butter substitutes for culinary purposes, and as a salad oil. It is reputed to keep well and not to turn rancid. The following abstract of a report of some recent work done in Russia shows that the oil has a high food value:—

"In comparison with butter, sunflower oil was of high, and suet of very low, nutritive value when fed to young rats as 30 per cent of the caloric value of the ration. The high biological value of sunflower oil was attributed to its content of highly unsaturated fatty acids. When groups of rats which had received the three rations were subsequently starved, the group which had received sunflower oil showed the longest survival period."—(A. M. Copping.)

Hot pressed oil is reddish-yellow in colour and contains mucilaginous matter from which it is purified with sulphuric acid as in the case of rape oil. It is a semi-dryer. Until recent years it could not be used for culinary purposes but modern practice now enables it to be refined and made edible. Unrefined hot pressed oil is used for soap-making and occasionally for burning. It is also said to be used in Russia and Germany for the manufacture of varnishes and paints and in Holland for enamel, but, as its drying properties are inferior to those of linseed oil, it is only if the price of linseed oil is abnormally high that sunflower oil can compete against it for such purposes. In the United States of America the poorer grades are used for wool dressing.

In 1923 an analysis of striped or grey Russian seeds grown in Kenya gave the following results which are compared with Hungarian seeds:—

	Kenya Grown Seed	Hungarian Seed
	Per cent	*Per cent*
Weight of Kernels ..	56·7	45 to 52
Weight of Husks ..	43·3	48 to 53
Oil Content of Kernels ..	44·9	36·6 to 53
Oil Content of Whole Seeds	25·4	—

Sunflower seed oil imported into the United Kingdom from Russia and Rumania is usually sold under a guarantee of, say, 1 to 2 per cent free fatty acids (the actual proportion averaging about ½ per cent) and a maximum of ½ per cent dirt and water. The oil is usually shipped in quantities of from 400 to 1,000 tons.

Sunflower Seed Cake

Sunflower oil cake from undecorticated seed has a low feed value owing to the high content of crude fibre in the seed coats. The value is too low to permit of long transport charges, consequently the trade in sunflower oil-cakes is almost entirely confined to cake made from decorticated seed.

The bulk of the world's cake is produced in Russia and Central Europe; the cake exports go mainly to Denmark; other importing countries are France,

Sweden and Norway. It is used for feeding cattle. There is no record of dealings in this cake on Mark Lane but it is probable that the meal is used in some of the proprietary cattle feeding mixtures on sale in the United Kingdom. Its use for pig feeding is not recommended as it tends to produce oily fat.

The analyses of the two kinds of cake, according to Smethan (Ann. J. R. Lancs. Agric. Soc., 1914), are as under:—

	Sunflower Seed Cake	
	Undecorticated	Decorticated
	Per cent	*Per cent*
Moisture	7·10	7·75
Crude Proteins	19·01	38·38
Fat	7·43	8·68
Carbohydrates, etc. ..	28·93	22·46
Crude Fibre	30·03	16·03
Ash	7·50	6·70
Nutrient Ratio	1:2·42	1:1·11

The food units of the cake in comparison with other cakes in use are as follows:—

	Food Units
Sunflower Seed Cake—Undecorticated	95
Sunflower Seed Cake—Decorticated ..	140
Linseed Cake, English Average ..	133
Cotton Seed Cake—Decorticated ..	157
Cotton Seed Cake—Undecorticated ..	107
Coco-nut Cake	122
Palm Kernel Cake	110

As the husks or seed coats are valueless the question of decorticating sunflower seed for shipment has received some attention. The opinion appears to be held by crushers, particularly in Germany, that such a procedure is not desirable, as the decorticated seed is liable to undergo decomposition through exposure to the air, with resulting adverse effects upon the quality of the oil.

Sunflowers as an East African Crop

In 1933 the price of sunflower seed was abnormally high owing to the failure of the Danubian crop the year before. Prices for some time were round about £25 a ton in London and one firm succeeded in making sales at over £30 a ton. A few farmers in Kenya were attracted by these prices and, as white seed was highest in value at that time, they planted imported seed of that colour and obtained from Sh. 12 to Sh. 8 a bag of 100 lb. net at their station during the first two years. The exports from Mombasa, mostly of white seed, were as under:—

	Tons
1934	106
1935	261
1936	316
1937 (Jan. to June) ..	180

Prices declined however, and with the rise in the value of maize, sunflowers as an export crop are ceasing to interest farmers. The Kenya Farmers' Association (Co-operative) Ltd., Nakuru, state that when the c.i.f. London value is £10 a ton, the f.o.r. value at Nakuru of a bag of 100 lb. net is Sh. 6/34 dropping to 87 cents a bag when the London c.i.f. price is £5 a ton.

In Kenya the yields of sunflower seed measured by volume are roughly the same as maize. That is to say if a certain piece of land yields an average crop of ten bags of maize per acre it is probable that it will yield ten bags of sunflower seed, but it should be remembered that the sunflower seed will weigh only half as much.

The sunflower plant is somewhat hardier, thrives better than maize under conditions of low rainfall and fertility and occupies the land for two or three months less; but against these advantages must be set the higher cost of harvesting and threshing, and the fact that if great care be not taken a large proportion of the crop can be lost by shedding.

There is no doubt that the exports of seed from Kenya were used for bird-seed. This trade is declining owing to parrot disease in the United Kingdom. A certain small amount of good quality light-coloured seed will probably always be needed but the demand is uncertain, and

it is doubtful whether East African growers can compete successfully with the peasant growers in the Danubian states. The extensive production of seed for export therefore cannot be recommended, although there may be periods in the future when a shortage in Europe may make it profitable. For this reason it is hoped that there will be a number of farmers who will grow the crop as a side line for home use; there will then always be a supply of seed in the country ready for a sudden and temporary expansion which may be highly profitable while it lasts.

It is open to question whether the white seed is the best to grow in East Africa; its delicate colour is easily stained and it is usually reckoned the poorest yielder. At the time of writing this article (June, 1938) black and grey seed are slightly higher in value. It is much easier to produce a good-looking sample of dark-coloured seed for export. The trade does not seem to care much what the exact colour is and it might be useful for the growers of Kenya to consider the matter, with a view to eliminating all kinds but the one on which they decide, and thus being able to market attractive bulk shipments of one kind of seed when prices are good.

As cotton seed is likely to become available in ever-growing quantities for cattle feed it is doubtful whether it will ever be profitable in East Africa for a firm to set up a decorticating plant for use in manufacturing sunflower oil and oil cake.

Within certain limits sunflowers can be of great value and should find a place on many farms. The following are its uses for East Africa:—

(*a*) Green manure.
(*b*) Ensilage.
(*c*) Sunflower head meal for stock.
(*d*) Poultry feed.
(*e*) A source of honey supply.

Growing the Crop for Seed

The growing of sunflowers presents little difficulty as the crop is not exacting. It has a somewhat wider range than maize in its endurance of both wet and dry climates and no serious diseases have been recorded. Locusts will not eat it if more palatable food is near. Fresh applications of manure depress the yield of seed but increase the bulk of green matter.

The sunflower is usually spaced 3 ft. or 3 ft. 6 in. between rows and 15 in. to 18 in. in the row. It is as well to drop two or three seeds at each spacing because cutworms may damage the seedlings. The plants must be thinned to the proper stand before they are 8 in. high or else they will be spindly and poor. Planting should be timed to allow for three to four months of rainy weather for growth and for harvesting to be done in dry weather. The crop requires weeding and cultivating until 3 ft. high, after which it will take care of itself until harvest.

Reaping and cleaning the seed are the most difficult operations with this crop. Heavy losses can be sustained if there is any mistake. Sunflowers do not ripen evenly and it is necessary to go through the field several times over a period of three weeks or so. If labour is short the crop reaped will be lowered as the heads shed easily and trouble will result if they are not ripe enough to give up their seed. The heads of white or grey seed should not be left to curl outwards in the field because exposed seed gets discoloured very quickly by dew and rain.

Harvesting.—The following method has given excellent results in producing seed of the best quality. Each labourer is provided with a pair of pruning shears, a basket or four-gallon tin and a few bags. The field is opened by cutting out six lines at intervals of 30 yd. or so for

carts or wagons to enter. The dry heads are harvested and the others stooked.

The best condition of the head is when it is nearly dry but still "leathery". There should be no green on the back of the head. Working one man to two lines the men cut off the heads which are ripe, as close as possible to the head, and drop them into the baskets. Rough handling must be avoided as the seed sheds easily. Using a knife instead of shears may cause considerable loss. When seed for export is being reaped each head should be looked over and discoloured or damaged patches of seed rubbed off with a stroke of the shears. This is most necessary with white seed if a good sample is to be obtained.

When the basket is full it is emptied into a sack. Sacks should not be filled: stout twine ties can be sewn to each sack for tying the mouth, or the sacks can be filled to only two-thirds of their capacity, allowing the top third to be folded over for loading. These precautions are necessary, for if heads fall on the ground most of the seed is lost. It is convenient to have the carts moving slowly along the adjacent lanes so that each reaper loads his sack on the cart as it is filled.

The heads are delivered at a threshing floor where threshers are waiting in the proportion of one thresher to two reapers. Heaps of heads must not be left overnight as the damp ones will develop a blue mould very quickly and light-coloured seed will be discoloured.

The reapers should follow the last loads in and help to thresh until all are finished.

Threshing.—An enclosed floor is best as seeds are scattered a long distance. If the heads are beaten hard they break up and masses of debris have to be picked from the seed even after winnowing. The best way is for the boys to pick up the heads singly, tap them a few times with a stick 18 in. long and then throw the bone-dry heads on one heap and the others on another. The latter can be dried for grinding into head meal.

The threshed seed should be sieved through a $\frac{3}{4}$ in. riddle to remove large pieces of head and then be winnowed with care. It must be done briskly in order to take out the light seeds; if a little good seed goes out with the lights there is no real loss because all winnowings should be saved to mix with heads for gristing into meal. Two winnowings are usually enough and then, if the seed is intended for export, any obviously defective seeds are hand-picked.

If careful attention has been paid to the ripeness of the heads the seed will be dry enough to bag at once. Bags should be weighed to $103\frac{1}{2}$ lb. gross and will arrive at the Coast with a loss of only $\frac{1}{2}$ lb. due to drying.

In America the field is reaped just before the majority of the heads are dead ripe. A wagon with a tight box is used with one high side-board. The reaper throws the heads against the side-board, which shells a good deal of the seed. A man in the wagon armed with a stick or a curry comb does the rest and throws the empty heads on the ground, thus doing away with the danger of heaping up unripe heads which will go mouldy.

Three men usually harvest and thresh one acre a day (where the planting is 3 ft. or 3 ft. 6 in. by 3 ft. with two plants to a hill). They have to take care to dry the seed as it would go musty if stored in large quantities. If the seed is spread 6 in. deep in the sun on tarpaulins for two or three days it will be dry enough to bag.

Yields.—In America, 800 to 1,200 lb. per acre, with a maximum of 2,000 lb. are obtained; in Russia, 800 to 2,000 lb.; in Kenya yields up to 1,500 lb. per acre are common; in South Africa the record is 3,000 lb.

Sunflowers as a Green Manure Crop

The sunflower will often thrive where a leguminous green manure will not. It is capable of yielding up to 30 tons of green matter per acre. It has the advantage of large seed, easy to collect and to sow, and is a useful type of plant where practical work is concerned. If given a fair start it goes ahead rapidly and soon shades out weeds. The crop transpires an enormous quantity of water and thus saves large amounts of soluble nitrates from being leached down into the lower strata of the soil during very wet periods.

The preparation of the land is similar to that for any cereal crop but the tilth need not be fine. Seed can be broadcast at the rate of 30 lb. to 40 lb. per acre on ploughed land and be harrowed in, or it can be drilled at 30 in. to 36 in. between rows and 9 in. to 15 in. in the rows, using 8 lb. to 12 lb. per acre. Preferably before it is 15 in. high, the young stand should, if possible, be given a cultivation and one weeding if the land is foul, after which it should overcome all annual weeds.

The best time to turn the crop under will usually be when it begins to blossom, but in certain districts west of the Rift it may be profitable to plant very early and turn it in during May or June. A short-lived crop to be reaped later in the year can then be planted on the land. If the soil is damp when the sunflower is ploughed in, crops can be planted after two or three weeks. The standing green crop is easily covered by a disc plough followed by a cross harrowing with a disc harrow.

The value of sunflower in coffee cultivation should not be overlooked; it provides an admirable bulk crop to be grown when building up box ridges.

Sunflower Ensilage

The green plants make good silage but used alone the result is liable to be too sour and it is usual to mix sunflower with green maize in the proportion of one of sunflower to three or four of maize. Seed is planted about 3 ft. by 8 in. or 10 in. and the crop is cut when the seeds in the heads are formed and the majority are in the milk stage: younger growth than this may make the resulting silage too sour and if cutting is delayed beyond the right stage the lower parts of the stems are too fibrous and become unpalatable. In Rhodesia the best silage has been made when the heads were fully formed and the flower petals beginning to wilt. In America yields of 20 to 30 tons per acre of green forage are recorded.

The feeding value of sunflower silage is computed to be slightly lower than that of maize silage and it is not quite as palatable: The difference is small, the digestible protein content of sunflower being higher and the carbohydrate content lower than that of maize silage.

Two important considerations in favour of using sunflowers are that under adverse conditions they will usually give a greater weight of food than maize and that the use of a second ensiling crop facilitates rotation on the land.

Sunflower Head Meal for Stock

Once cattle have acquired a taste for sunflower heads they will eat them readily. For milling, the heads should be dry and crisp. The ordinary cob mill will reduce them to a fine meal with little effort, but they must be quite dry. If a cob mill is not available the dry heads can be pounded up with a wooden pestle.

Poultry have been fed successfully for a period of several months with a mash in which sifted sunflower head meal was substituted for half the bran ration.

If cattle are shy of eating the meal when first set before them, kibbled maize sprinkled on it will soon teach them. As a small proportion of the seed is usually

left in the heads in will be found that the oil in the meal improves the condition of the animals.

On the Government farm, Gwebi, Southern Rhodesia, sunflower head meal is made up with from 5 per cent to 10 per cent of seed and is used for stock feeding combined with other feeds. An analysis of this meal was made by the Chemical Section of the Department of Agriculture, Southern Rhodesia, and it compared with wheat bran as follows:—

	Sunflower Head Meal (With 5 per cent to 10 per cent Seed)	Wheat Bran
	Per cent	*Per cent*
Moisture	14·00	13·2
Ash	9·90	5·9
Protein (N × 6·25)	8·84	14·3
Ether Extract	5·86	4·2
Fibre	31·70	10·2
Carbohydrates	29·70	52·2

The value of the seed for feeding poultry is mentioned below in the following note published by the Department of Agriculture, Southern Rhodesia. Caution, however, should be used in feeding the seed owing to the high fibre content and excessive amount of fat. It is considered that sunflower seed should not be fed to poultry in excess of 5 per cent by weight of the total ration:—

"Sunflowers for Poultry Feeding

There is no doubt that sunflowers are the most economical and useful plants grown as a poultry food. Nearly every part of them is of some use, as the following will prove.

The seeds, and especially the small black, are largely used as a poultry food. They are nourishing, of excellent food value, good egg producers, and for the growth and nourishment of feather there is only one other grain, viz. linseed, which is better, and they contain certain properties which act as a corrective. The nutritive ration of sunflower seeds is 1–4.5, which is as near as possible that required for a fowl to be in good health and produce eggs in quantity.

The green leaves are an excellent green food and much relished by fowls. They should be cut up into half-inch pieces, and placed in some receptacle, *never* thrown on the ground. The stalks of the leaves, too, should be given and treated in the same way; in fact these are relished even more than the leaves. The following is their chemical analysis:—

	Per cent
Water	78.73
Ether extract (fat) ..	0.70
Protein	4.12
Carbohydrates ..	10.53
Crude fibre	1.97
Ash	3.95
	100.00

The nutritive ratio is 1–2.9; lucerne is 1–3.2.

The dried leaves broken up and made into a meal are most useful to mix with the dry meal or soaked with hot water and squeezed out as dry as possible and fed separately in troughs. The method of treating the leaves for this purpose is as follows: When the plants are from 3 ft. to 3 ft. 6 in. high, commence stripping the lower leaves, leaving a good cluster at the top of the plant. Expose them to the sun on sheets of iron or any hard surface, care being taken that they are not allowed to become musty. Spread them out thinly and turn occasionally, two or three hours in the hot sun is usually sufficient to dry them thoroughly. A little rain or dew on them is not detrimental, but the weather must not be too damp. When the leaves are dry, place in sacks and hang these up for two or three days, then rub through an $\frac{1}{8}$ in. mesh sieve. What passes through the sieve forms an ideal sunflower leaf meal and ideal green food for mixing with the dry mash. What remains, i.e. the ribs of the leaves and stalks, when scalded with hot water and squeezed out as dry as possible is readily eaten by the birds.

The following is the analysis of the dry leaves:—

	Per cent
Water	14.87
Ether extract (fat) ..	2.82
Protein	16.50
Carbohydrates ..	42.15
Crude fibre	7.87
Ash	15.79
	100.00

The nutritive ratio is 1–2.9, the same as that of the green leaf.

The sunflower heads, minus the seed, dried and ground to a meal, are useful for mixing with the dry mash. The chemical analysis of this is as follows:—

	Per cent
Water	11.73
Ether extract (fat)	3.18
Protein	8.86
Carbohydrates	46.42
Crude fibre	18.19
Ash	11.62
	100.00

The nutritive ratio is 1–6.04; that of wheaten bran is 1–3.1; that of mealie meal is 1–8.9.

We have not yet finished with the sunflower plant; there is still another part of it, viz. the pith in the dry stem, which is an excellent food for poultry, especially young chickens in their feathering stages. It is quite a good food, but especially is it a good feather producer. Fowls and chickens when growing their feathers require some special food of this kind to assist them in producing these quickly, otherwise material from the ordinary food given them is used, with the result that there is not sufficient left to also produce in adult fowls, eggs, and in chickens to supply sufficient material for good and quick growth of flesh and bone, etc.

Linseed, sunflower seeds, hemp seed and some green foods have the same properties, i.e. the production of feathers, but the pith in the stem of a sunflower plant is much cheaper and more economical. All that is necessary is to take out the pith, crumble it up before the fowls or chicks, when they soon become accustomed to and very fond of it, subsequently the stems can be split and laid in the runs, and the birds will do the rest.

From the above it will be seen what a valuable and economical plant the sunflower is to the poultry keeper; it has, too, the advantage of being easily grown, and is a handsome plant in any garden."

A Source of Honey Supply

Sunflowers produce the finest honey and wax. Bee keepers would find it profitable to plant plots of sunflowers every two weeks from the beginning of the rains until within six weeks of the end of the wet season. Their bees would then have a steady supply of the best nectar close at hand. If bees have to range far the honey harvest is small. Fresh swarms will be attracted by such a succession of desirable flowers.

Sunflower Ash

Sunflower stalks have a high potash content and should not be wasted. After a standing crop has been reaped the stalks may be laid by a pole dragged over them and then cut up by a disc harrow or they may be ploughed in straight away and cross harrowed with a disc harrow. If any stalks left lying on the surface are burnt the ashes should be scattered in order that the valuable mineral constituents be used as profitably as possible. The ash from the stalks will contain about 25 per cent of potash, 12 per cent of lime and a small proportion of phosphoric oxide.

Seed Selection

As sunflowers inter-breed freely it is important that, when a pure strain is to be preserved, different coloured seed should not be planted within a distance to allow bees to cross pollinate the flowers. This will be a matter of a few miles, hence the desirability of one kind being selected for a district. Many plants in a field show undesirable characteristics, such as branching and bearing a number of small heads.

The best type of plant is robust and bears one large well-formed head full of heavy well-filled seeds. These should be selected in the field for seed, care being taken to avoid plants that are growing under abnormally favourable conditions which might mask a weakness inherent in the plot.

Where plots are planted for seed all plants with a tendency to undesirable features should be pulled out before they blossom.

The Length of the Pruning Cycle*

By F. R. Tubbs, *Ph.D.*

The length of existing pruning cycles has been in the past roughly adjusted to give the best yield under a given set of conditions. The focusing of attention upon quality rather than yield in the last few years has resulted in more thought being given to the advantages or disadvantages of a longer cycle. Suffice it to say here that both laboratory experiments and estate experience has shown conclusively that better teas are made as the age of the tea from pruning increases, while the improvement continues, at this elevation, even during the fourth year from pruning. Thus the change is a progressive one and is not sudden or irregular. Now it has been found that similar progressive changes occur in the bush and in the character of the crop and it is for that reason that I have chosen to describe them to-day.

Commencing with the pruned bush, which has suffered a drastic reduction in its leaf surface, its branches, and its shoot initials (or buds), we find that it reacts by attempting to restore the *status quo ante*. The rapidity with which it succeeds is at first relatively great but this falls off until at the end of the cycle the changes are, in comparison, very slow.

The first stage is the production of the primary shoots from the pruned frame. The number formed is largely influenced, though not entirely controlled, by the number of buds upon the frame. It is also affected by the amount of young wood in the frame, Thus, a high cut-across produces such a profusion of primaries that tipping is quite unnecessary. Associated with the large number of primaries is less vigorous growth on the part of individual shoots and plucking may be carried out as soon as they have developed sufficiently. With more severe types of pruning the number of primaries produced is far less, and, being developed from different levels upon the frame, their attainment of a sufficient height above the pruning level is by no means simultaneous. There is no point in collecting, at relatively high cost, poor quality leaf and so they are allowed to develop freely until tipping is performed. The stage at which this is performed will be dependent upon the crop position, but the aim is the same whenever it is done—namely, to produce a level plucking surface and to increase the number of shoots in it. The formation of laterals upon the primary shoots is not entirely dependent upon tipping, since if the process is delayed many secondaries will be found at the tipping level, but if it is done before these are naturally produced, the process is hastened. At no stage save that of the production of primaries does the number of shoot initials upon the bush seem to limit the number of shoots produced. In fact, it appears that at the end of a three-year cycle the average bush has several thousand dormant and unused buds upon it.

Normally, the first tipping is succeeded by a second and third at varying intervals, but this appears to be an unnecessary extension of the process. It would seem more reasonable to delay the first tipping a little (if necessary) in order to enable the majority of the primaries to be dealt with on that occasion. Then, when young shoots appear upon the surface of the bush, commence the normal succession of plucking rounds. This would permit of a reduction of labour,

*Reprinted from *The Tea Quarterly*, Vol. X, Part I

while, providing tipping was not done too early, the leaf obtained at the following plucking would not be of the so-called "tipping type".

The operation of plucking results in multiplication of the number of shoots in the plucking table and in the production of shoots in various stages of development. Thus we must recognize a second stage in the history of the pruned bush, namely the formation of an efficient plucking table in which the number of shoot initials is sufficient both to ensure that the new shoots are practically all produced near the plucking surface and not deeper in the bush, and to provide a succession of developing shoots to provide crop at subsequent plucking rounds.

The time occupied by this stage will depend upon the number of shoots in the surface formed at tipping, and this in turn will depend upon the type of pruning employed, and also upon whether the tipping was sufficiently late to allow of secondaries being present in the tipping surface. Thus cutting-across results in this stage being relatively short, while at elevations where dieback is prevalent as a result of low carbohydrate reserves, lung-pruning has a similar effect. Again, the stage is relatively short where bushes which have been rested for a moderate time are tipped high. This is due to the relative density of shoots in the tipping surfaces of such bushes.

Following upon this we get a stage in which the plucking table increases in area, and decreases in yield per unit area, until the bush is again pruned. The increase in size of the plucking surface does not keep pace with the decrease in its efficiency, so that the yield per plucking tends to fail. At the same time the rise in height of the plucking surface results in the weaker shoots being left behind, so that they are no longer plucked. They occur inside the bush but are especially numerous upon the sides of the bush.

These stages merge with one another and cannot be clearly separated, but throughout there runs the theme of increasing total shoot number, a theme which is unfortunately not adequately reflected in the crop obtained. Simultaneously, other progressive changes are found to occur, which may now be discussed.

TABLE I

Elevation in feet	Time of pruning	Mean weight in grams 1st year	2nd year	3rd year	4th year
4,600	Sept.	0·126	0·092	0·089	0·087
	Jan.	0·014	0·091	0·089	0·088
	May	0·100	0·088	0·089	0·087
1,600	May	0·141	0·118	—	—
200	May	0·134	0·112	—	—
	May	0·141	0·123	—	—

If the plucking standard and the length of the plucking round are held constant, a decrease in the average size of the flush harvested may reflect either a decrease in the final size attainable by the leaf, or a slower rate of growth of the leaves and stem forming the flush, or a combination of both. It is well known, for example, that mature leaves produced after pruning are larger than similar leaves at the end of the cycle, while some indications of a slowing down of the development rate of the flush toward the end of the cycle have been found. The figures in Table I illustrate the changes that occur in the weight of a flush consisting of two

leaves and a bud. Bearing the interpretation I have suggested in mind, it will be seen that there is evidence of progressive changes during the cycle in the potentialities of the shoots.

It will be seen that the crop consisted of smaller and smaller flush as the cycle become relatively constant. This suggests that it becomes controlled by internal factors, rather than external. When the average shoot weight is plotted against years from pruning it is found that they lie along a curve of definite form (Fig. 1). The close fit of the curve in

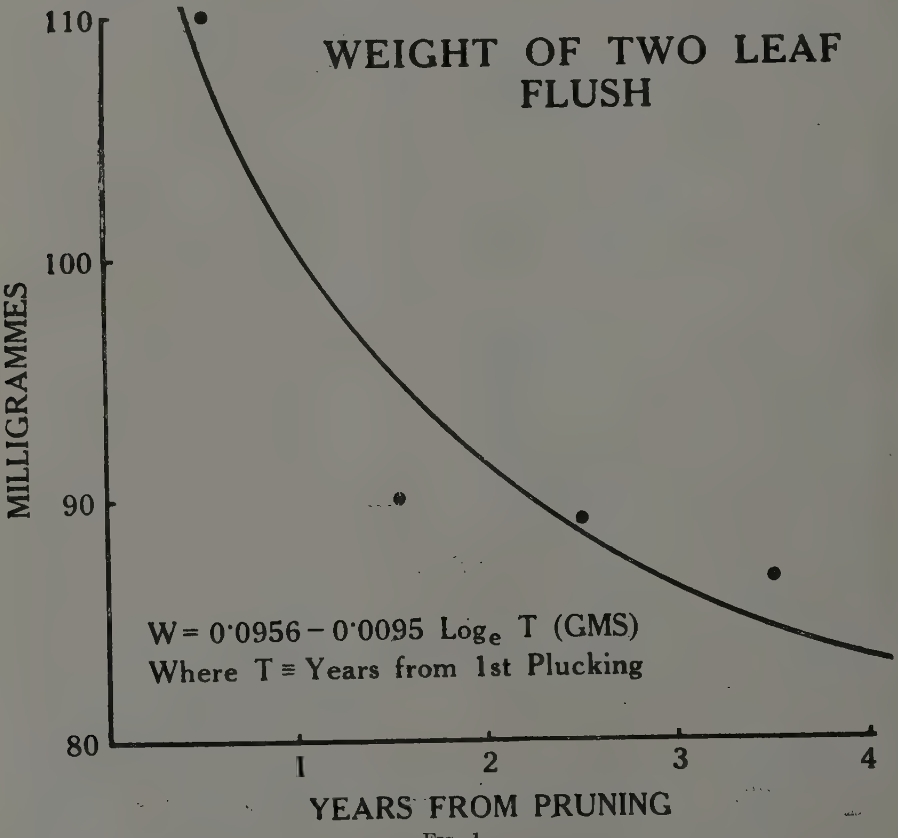

FIG. 1

progressed, and that the fall in size is most rapid in the early part of the cycle. Comparison of the data obtained at 4,600 ft. suggests that while differences in climate affect the size to a fairly marked extent in the first year after pruning, in subsequent years it tends to spite of irregular changes in climatic conditions from year to year lends support to this view of the importance of the internal factors.

Not only does the size of the flush alter, but also the proportions in which the different components of the flush

occur. A comparison of flush grown under the same climatic conditions, from closely adjacent bushes gave the following results (Table II). The dry weights of the various portions of the flush are expressed as a percentage of the whole, neglecting the basal portion of the stalk.

TABLE II

	Months from Pruning		
	5	48½	Difference
Bud	9·22	10·03	Not significant
1st leaf ..	22·61	26·01	Significant
2nd leaf ..	59·60	54·39	Significant
1st (bud) internode ..	1·90	2·09	Significant
2nd internode	6·68	6·88	Not significant

They indicate that the internode supporting the bud and the first expanded leaf form a larger proportion and the second leaf a smaller proportion, of the flush from the 48½-month series, compared to that from the five-month series. One explanation of this would be that the leaves were developed from the bud more slowly, which would suggest that *both* of the factors previously mentioned as influencing flush size are at work.

The extreme case of slowing down of the bud's activity is exemplified by "banji" formation, when the bud becomes temporarily dormant. An examination of the occurrence of banji indicates that, while banji are always present, the proportion in which they occur increases with the age of the field from pruning. This is reflected in a corresponding reduction in the percentage of flush, which is obvious from the data in Table III which were collected from the crop of fields of different ages from pruning.

TABLE III

Age from Pruning in Days ..	Percentage of Flush (Actively Growing Shoots)
145	87·1
160	93·6
190	72·4
210	68·5
270	55·2
280	56·2
330	68·2
420	55·0
450	59·5
625	53·8
720	60·4
1,500	53·9

A similar relation with time is found to occur as was found in the case of the size of flush (Fig. 2). It is interesting to note that in this kind of curve, the rate of change is inversely proportional to the time elapsed, the decrease in both the size of the flush and the percentage of actively growing shoots (flush) being most rapid at first and becoming slower and slower. Now we have already noted that during the progress of the cycle the changes in the bush are those associated with increasing numbers of shoots upon the bush. Our information is as yet insufficient for proof, but it seems likely that these changes in the growth of individual shoots are connected with the increase in their number. Such a conclusion would lead immediately to the suggestion that competition between the various shoots was of importance.

It may be objected that the changes in the frequency of banji are not only associated with age from pruning, since seasonal fluctuations occur, their amount being less during periods of rapid growth. At first sight this does not appear to fit in with the idea of the importance of internal competition. Data on this are at present in course of collection, but meanwhile it is of interest to note that seasonal

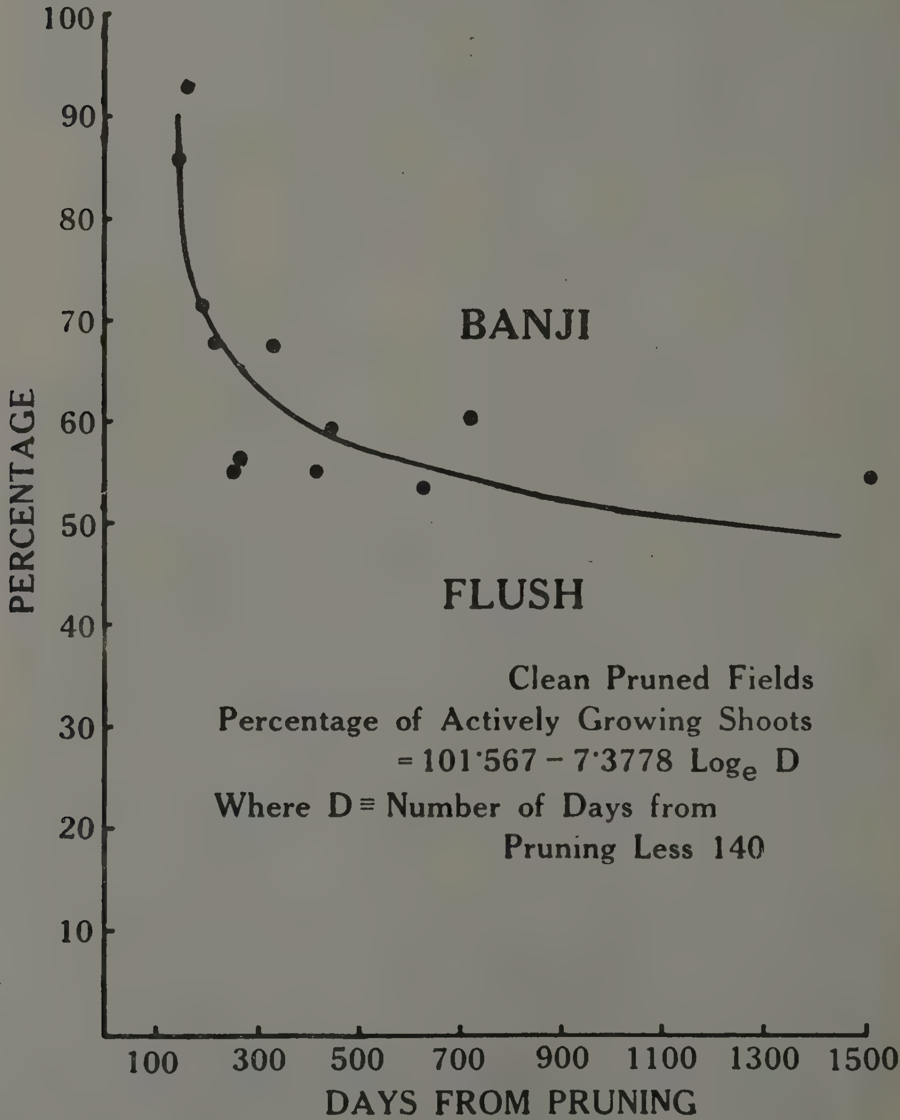
100
90
80
70
60
50
40
30
20
10
PERCENTAGE
BANJI
FLUSH
Clean Pruned Fields
Percentage of Actively Growing Shoots
= 101·567 − 7·3778 Log$_e$ D
Where D ≡ Number of Days from
Pruning Less 140
100
300
500
700
900
1100
1300
1500
DAYS FROM PRUNING

FIG. 2

changes in crop were found by Dr. Eden to be associated with similar changes in the percentage of nitrogen in the flush. In other words, when shoots were growing rapidly and when banji was presumably smaller in amount more nitrogen was available per shoot. So the seasonal changes that occur would not appear in the present stage of our knowledge to be a sound objection to the suggestion of competition.

We see then, that the ageing of the bush may be associated with a decreasing supply of nutrients per *shoot* as the total number of shoots upon the bush increases. If this is the case it leads immediately to the idea that if pruning is to be delayed, increased nutrient must be made available to the bush, and this has, in practice, been found to be the case. However, before discussing the measures to be taken when increasing the cycle I will briefly refer to some of the yield records obtained under a constant system of manuring throughout the cycle. I have already said that the increase in size of the plucking table is accompanied by a decrease in the yield per unit area in the latter part of the cycle, with the result that yield tends to fall. The rate of fall is influenced by manuring, but the yields shown in Table IV were obtained from clean-pruned bushes when this was kept constant.

TABLE IV

Elevation in Feet	Mean Yield in Lb. per Plucking (1,500 Bushes)			
	1st year	2nd year	3rd year	4th year
4,600	12·66	10·92	8·18	5·82
1,500	12·13	10·44	—	—
	8·33	7·24	—	—
200	8·01	12·45	—	—
	7·78	12·28	—	—

It will be seen that except at the low elevation where dieback after pruning is prevalent, the highest rate of yield occurs in the first year. Considering the case of low-country estates first, the effect of dieback is to increase the actual severity of the pruning and thereby to delay the formation of an adequate plucking surface.

Increasing the rate of formation of the plucking table as a result of reducing dieback by lung-pruning increases the yield per plucking in the first year, while the relatively "ready made" character of the table resulting from a high cut-across has an even more marked effect. These points are illustrated by the data given in Table V which refer to the experiment conducted at Galatura (200 ft.).

These figures suggest that low-country estates on which the tea is in good heart may not be running as long as possible. As indicative of the state of the tea to which I am referring the yield was 2,192 lb. per acre in two years, during which time it received a *total* of 120 lb. nitrogen per acre. It would be of interest to attempt, say, a thirty-month cycle on a small area of such tea, keeping the bushes in control by careful and continuous breaking back after the first fifteen months from pruning. It is essential, however, that the leaf area should not be reduced by such treatment during the first year, when yield and leaf area are so closely connected.

TABLE V

	Mean Yield in Lb. per Plucking (250 Bushes)		
	Clean	Lung	High cut-across
First year ..	1·30	1·49	2·18
Second year..	2·05	2·27	2·44

On by far the largest area of tea in Ceylon, however, the question of longer cycles will depend upon whether they can be obtained without a reduction in crop so large as to render them uneconomic, or alternatively, without the manuring programme necessary to maintain crop being too expensive. For relatively few is the question of crop of prime importance at present and I would suggest that the present time provides the opportunity of discovering whether under your particular conditions, an extended cycle is likely to be of advantage.

Assuming that the decision to extend the cycle is taken—either over the whole estate or on one or two trial fields—what should be the programme?

It is the custom in Ceylon for the cycle to be a whole number of years in duration, the number of estates having cycles of, say, thirty months or thirty-nine months being relatively small. I suggest that it is desirable that the cycle should not be a multiple of years, in order that an alteration in the season of pruning of individual fields should occur. Even in this district, where the climate cannot be regarded as grossly vagarious, it appears from the limited data at our disposal that August and September are the most favourable months from pruning. Why should one or two fields receive the benefit of always being pruned at this season?

The length of the proposed new cycle being settled, the initial pruning should be proportionately more careful. The less frequent pruning involved by longer cycles demands that extra attention be paid to the removal of snags and dead wood, the preservative treatment of pruning cuts, and the encouragement of spread by carefully leaving the fringe branches. No saving, therefore, should be made in the cost per pound of the pruning operation over the cycle.

Plucking will obviously demand greater care. Whereas in a short cycle the bushes are easily managed, irregularity in the plucking surface due to inefficient breaking back must result in poorer plucking when the bushes are getting high. I am not suggesting that the plucking table should be flat—in fact on a long cycle it is impossible to prevent the centre rising unless very severe breaking back is done. But I do not think it is a coincidence that those estates I know of that succeed in obtaining good yields in the last year of an extended cycle are also remarkable for the even surface of the bushes and the absence of exaggerated doming in the centres.

In the absence of Dr. Eden I do not wish to say much on the subject of manuring, but its mention is necessary in connexion with the lengthening of pruning cycles. The suggestion I have made, that there is an increasing competition between the shoots during the course of the cycle immediately brings the subject into prominence, and suggests an obvious series of tests. If banji formation, for example, is partly an effect of this competition, additional nitrogen should have the effect of reducing its frequency. Dr. Eden's manurial experiments afforded the opportunity of making preliminary tests on these points.

These investigations have not yet been finished but so far the indications are that the percentage of banji occurring in the crop is decreased by nitrogenous manuring. The effect of nitrogen upon the size of the flush is not large and it requires further investigation; it would appear that the effect on the proportion of banji is the main one.

We have already noted that the relative sizes of the various portions of a single

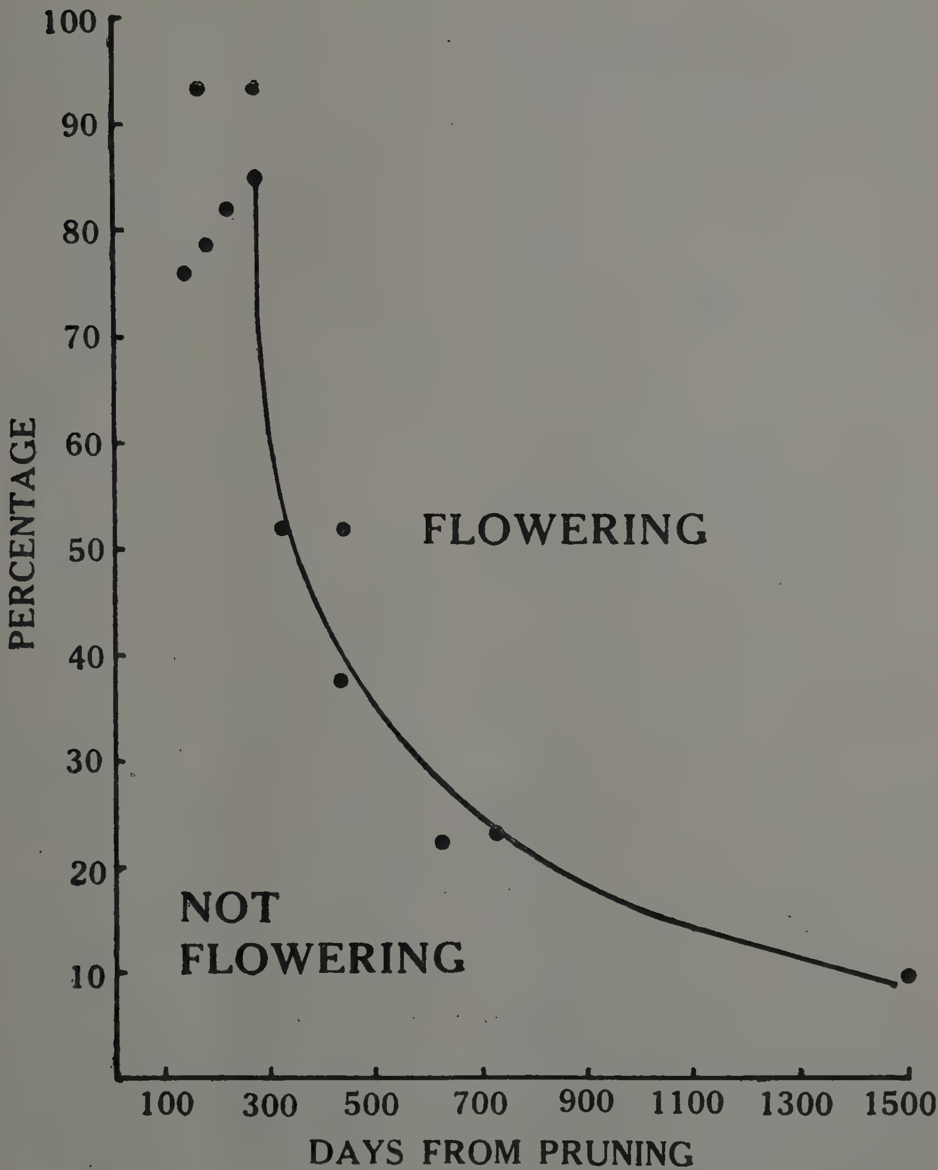
100
90
80
70
60
50
40
30
20
10
PERCENTAGE
FLOWERING
NOT FLOWERING
100 300 500 700 900 1100 1300 1500
DAYS FROM PRUNING

FIG. 3

flush change with age. The percentage weights of the components shown in Table VI, reveal no indication that extra nitrogen tends to produce a more "juvenile" type of flush in this respect.

TABLE VI

	0 lb. N.	20 lb. N.	40 lb. N.
Bud	13·71	13·80	13·81
1st leaf ..	28·85	29·23	27·73
2nd leaf ..	49·10	48·17	49·77
1st internode ..	2·08	2·21	2·18
2nd internode ..	6·26	6·50	6·51

Thus we see that indications have been obtained that, while extra nitrogen tends to reduce the effects of increasing age from pruning that I have tentatively attributed to internal competition, it does not appear to alter the gross morphology of the shoot itself.

In passing, another point connected with the length of the cycle may be mentioned. The occurrence of flowers upon the bush is often taken as indicating that it needs pruning. This is an indirect and, if not very cautiously used, an extremely fallible guide. The change from vegetative growth to the formation of flowers is usually well marked in temperate trees, which are in general characterized by well-marked periodicity in their type of growth. Species which are found in more uniform climes in which seasonal alterations are relatively small are found to display a much more bewildering habit. We know in our garden trees that one may be leafless and the other covered with foliage; one flowering, and the other fruiting. Nor is this confined to different trees, for of the branches on the same tree, some may be in the so-called reproductive phase, while others are growing vigorously. Tea appears to behave similarly. Flowers on the low side branches which are not being plucked need not be worried about; it is only when the branches composing the flushing table start to flower that yield is likely to be affected.

Examination of the occurrence of flowering in fields of varying ages showed that some bushes start flowering almost as soon as they are pruned, but that the numbers doing so rapidly increase after about nine months from pruning in the case of the mixed jât we have on St. Coombs (Fig. 3). There is only a very small increase in the percentage of bushes flowering after the third year from pruning. The graph suggests that if we were to prune when flowering shows a rapid increase, we would be on a nine- or ten-month cycle! Flowering therefore affords no real criterion of the best length of cycle. Yield combined with the character of the made tea is the only criterion we should accept.

You will notice that in this paper I have been assuming that a longer cycle is contemplated. I have asked Mr. Lamb to speak after me to give the reasons for this. While I certainly do not advocate rash extensions of the cycle without care and preparation, we must remember that pruning is at best a necessary evil, to be inflicted as rarely as possible, while Mr. Lamb's investigations have shown improved teas may be expected from longer cycles. We see in Ceylon two-, three- and four-year cycles, and very few of say, three-and-a-half. Surely, the best cycle for each estate does not fall so conveniently into such arbitrary classes? I put it to you that the length of pruning-cycle should not be regarded as fixed and immutable, but that its length should be carefully considered in relation to the conditions affecting the individual estate and, if found desirable, it should be altered.

Reviews

REPORT ON INVESTIGATIONS INTO THE DAIRY INDUSTRY IN NEW ZEALAND AND AUSTRALIA, NOVEMBER 1937–JANUARY 1938, by J. D. Chater, General Manager, Kenya Co-operative Creamery, Limited, Naivasha.

The General Manager of the Kenya Co-operative Creameries made during 1937–1938 an extensive tour of New Zealand and Australia in order to investigate methods of production of butterfat on the farm and the manufacture of butter in the factory in these two countries, and the information which he collected has been published in this useful and comprehensive report.

Conditions and Production in New Zealand.—Although the dairy industry is the second most valuable industry in New Zealand, it is mainly confined to a comparatively small area of highly intensive production, the average size of the dairy farm being only 50–60 acres with herds of from 40–50 cows. Butterfat production has been raised to averages of 117 lb. per acre and 217 lb. per cow, this latter figure being probably six and the former three times the respective Kenya averages. The stock-carrying capacity of the land has been increased largely by the use of superphosphate and pastures consisting mainly of Perennial Ryegrass and clover. While results of applications of phosphatic manures to pastures in Kenya have been frequently disappointing, the ability to increase the stock-carrying capacity on many farms to figures as high as 1½ beasts per acre has already been demonstrated by proper treatment and the use of good species. That there is tremendous scope for increase in this way there can be little doubt. Further, the exceptionally high yields obtained in many dairy herds indicate the scope for improvement in this respect, except in the very extensive ranching areas.

In spite of favourable conditions in New Zealand, however, high land prices, high labour costs and breeding and udder troubles, such as contagious abortion and mammitis, combine to render dairying a proposition which does little more than yield a bare living to the farmer. Wastage in dairy herds is very high and cull cows of the Boner type have values of £3–£4, which are similar to those prevailing to-day in Kenya.

The local market absorbs less than 10 per cent of New Zealand's output of butterfat and so has ceased to be a factor affecting the price of the product. It is interesting to note that this applies with almost equal truth to Kenya to-day.

The average annual production per supplier in New Zealand is approximately 5,700 lb. and the average monthly production per supplier rather under 500 lb. These figures are higher than in Kenya.

Owing to the fact that hired labour is almost unobtainable in New Zealand, the farms are worked almost entirely by the owner and his family, or where labour is employed it is engaged on a share-milker system by which the workers receive $\frac{1}{3}$–$\frac{1}{2}$ of the cream cheque for their labours. Milking is carried out almost exclusively by machines, which are largely worked with electric power from Government hydro-electric installations. Fairly rigid inspection of buildings and premises is carried out by Government inspectors, new buildings being erected to Government specifications and the average standard of cleanliness and hygiene is somewhat better than on the average Kenya farm. Apparently the majority of milking sheds are permanent, and port-

able milking is not commonly practised. It would appear that in Kenya, where the portable system is being extended, enforcement of conditions with regard to buildings might be undesirable, although a considerably higher standard of cleanliness could be ensured by Government inspections.

Owing to the intensive nature of production, more frequent cream deliveries are possible than in Kenya at present. Collection of cream daily, including Sundays, by lorry is an almost universal practice. Great stress should be laid on this fact since, owing to the scattered nature of our farms and the inadequate methods of communication, Kenya is unfavourably placed in this connexion. Many of the defects in the cream supply, blamed on the farmer, are in fact due to infrequent and delayed deliveries.

Dairying in New Zealand is very seasonal, commencing about 1st August and continuing for approximately nine months, while for the remaining three months supplies are so small that the factories only collect every other day. Yet, in spite of this being the winter period, the less frequent collection is immediately reflected in their butter grading, which falls from "Finest" to "First". The advantages of this seasonal inactivity are considerable, since it enables factories to give the necessary compulsory holidays and the farmer to rest from the regular routine of milking. In Kenya, however, there are no such arguments in favour of seasonal inactivity and every effort should be made to lengthen the period of production in the dry season.

Factory Buildings and Equipment.—The standard of factory buildings is as high in Kenya as in New Zealand. Equipment in New Zealand is designed primarily to reduce labour costs and to facilitate cheap handling, since wages average £4 per week for a maximum 48-hour week. Various automatic devices are therefore used for handling the cream and washing the cans. Power is usually supplied to the factories by electric supply from the Power Board, although some factories generate their own from internal combustion engines or with steam. The cream received is neutralized for acidity, but the amount of acidity to be neutralized is very low as compared with that in Kenya, only 1–2 lb. of neutralizer being required in a 200-gallon vat. Bicarbonate of soda is in general use for the purpose although some factories use proprietary Wyandotte C.A.S., claiming that this gives less foaming.

Grade terms used for cream are "Finest", "First" and "Second", and cream is graded on the quality of butter that would be made from it if churned alone. Sampling is performed at the same time as grading and, on account of the fresh nature of the cream, presents less difficulty than in Kenya. Period testing is practised, i.e. samples are collected and preserved, later bulked, and tests made three times monthly from the composite samples. This leads to a considerable reduction in costs as compared with the Kenya system of daily testing. Many factories only send out one cream and butterfat receipt when each test has been completed.

Various systems of cream pasteurization are in use in both Australia and New Zealand, three being generally recognized, viz. the Batch or Holding method, Flash method and Vacuum method. Opinion in both countries is that the Batch method, which is that used in Kenya, is out of date, and one of the other two is used. Where the cream supply is almost perfect the Flash method is preferred but in districts where the supply of cream is not so good, owing

to food flavours, higher temperatures, or imperfect methods of production on the farm, the Vacuum system is in general operation. It will remove volatile flavours, to which class most feed flavours belong, and it will also lessen the harmful effect of non-volatile flavours. The highest percentage of choicest grade butter is produced in factories using the Vacuum system of pateurization, 85 per cent of their butter coming into this grade, compared with only 50 per cent for those using the batch system. A change to the Vacuum system from the Batch system would not involve scrapping the holding vats at present in use in Kenya, since these can be incorporated in the Vacuum process.

Internal worker types of churn are in general use in both countries, the "Simplex" type as used by the Kenya Co-operative Creamery being criticized only on account of its slowness, and because control over moisture content is imperfect. This latter factor is of considerable importance since the factories show an over-run of 15.7–15.8 per cent with great regularity as opposed to 13.6–16 per cent with the internal worker churn. Various other machines, including an all-metal churn, were inspected and also a machine for the production of butter without churning by pumping cream through nozzles under pressure and subjecting it to intense chilling.

Packing is largely mechanical, in contrast to the hand methods used in this country, but output and labour costs are a determining factor in this respect. Considerable difficulty is experienced in obtaining box timber in both countries and in Australia shooks are even imported from Scandinavia.

Storage, accounting and grading.—In both countries storage is carried out at the shipping ports and large co-operative cold stores have been built for the purpose. Factories only possess small stores for chilling the day's make to a temperature of about 30°F., railing daily to the stores at the ports in ordinary insulated vans. The haul is, however, short, seldom exceeding 100 miles. As export supplies from Kenya increase, it will probably be desirable to expand storage facilities at the Coast on similar lines.

Systems of accounting do not show any improvement over those used in Kenya.

Operating costs per pound of butterfat vary in New Zealand from 1½d. per pound in the larger factories to over 2d. per pound in the smaller. Considering the smaller scale on which the Kenya Co-operative Creameries operate, the Kenya figure of 15 cents per pound compares very favourably with these, although it must be remembered that it excludes cream collection costs and railage to the Coast, which are incorporated in the New Zealand figures quoted. The total output of the five factories of the K.C.C. is only equal to that of one large factory in New Zealand.

Butterfat is paid for in New Zealand by a monthly advance at uniform rate and a deferred payment at the end of the year. The K.C.C. system of monthly payouts is superior, since the maximum amount of cash is paid to suppliers at the earliest opportunity and there is no possibility of the company having to call on suppliers for a refund in case of a falling market.

All dairy produce for export is graded by Government graders and stamped with the official grade mark. In addition to these grading services the Government renders very considerable assistance to the industry in the form of chemists, field staff, a dairy research institute, supervision of methods of production, check testing

and sampling in the factories, issue of certificates to graders and testers, and it also assists companies in the payment of other field and testing officers.

Pastures and pasture improvement.—Mr. Chater draws attention to the yields of grass obtained in New Zealand from certain species and mixtures and the value of superphosphate for pastures, and also to the desirability of conserving the grass as hay and silage during flush periods. Unfortunately few of the practices used in New Zealand are applicable in this country, where herbage and grasses differ so greatly and the problems have to be tackled from a different angle. There is tremendous scope for pasture improvement in this country, as instanced by a case where veldt that normally carries one beast on 5–6 acres is carrying, after cultivation and planting with a suitable grass, one-and-a-half beasts per acre. It has been stressed repeatedly that in many parts of Kenya breeding is rapidly outpacing ability to provide for the stock and the New Zealand example should be followed to increase our output of both grass and fodder crops even on the poorer land, particularly as drought conditions are of more frequent occurrence and of greater intensity than in New Zealand.

Australia.—Much of what has already been written about New Zealand applies to Australia except that in the more scattered districts in Australia, conditions approximate more closely to those in Kenya, cream supplies and deliveries being faulty and irregular. Furthermore, in South Australia the factories are almost entirely proprietary and the worst features of competition are in existence, such as uneconomic transport and slow and irregular deliveries, with a consequent unfavourable effect on the quality of the butter. The Vacuum system of pasteurization is favoured generally. The extra transport charges incurred by regular daily collections would not be justified in these sparsely populated areas and since conditions are similar to those in Kenya, the methods adopted indicate that the present policy of the Kenya Co-operative Creameries with regard to deliveries is probably justified until the land is more closely settled.

Manufacture of Casein.—The possibilities of manufacturing casein and skim milk were investigated. Rennet casein is quite beyond the power of Kenya to produce economically. At Messrs. Allen and Hanbury's factory in England it was shown that the process was a highly complicated one and not possible to operate at present under Kenya conditions.

In the case of lactic casein, which is easier to manufacture, very large capital is required for equipment, as witnessed by expenditure in factories in New Zealand and Australia. Casein is manufactured from milk skimmed by power at factory-owned collecting and separating stations, which are often converted cheese factories, because butter plus casein has proved more profitable than cheese manufacture. Production must be on a large scale to be economic, approximately 18,000 gallons of milk from which butterfat is removed being used daily in each factory. The system of precipitating the curd on the farm in Kenya and sending it later to a central factory does not offer any possibilities owing to the variable nature of the product. In Kenya it would appear better to use the skim milk for feeding stock.

Cheese.—Cheese production has tended to decrease in recent years, firstly because farmers are unwilling to undertake the extra labour of milk delivery for a small increase in returns and secondly because butterfat and casein have proved more

profitable. Cheddar cheese is manufactured almost exclusively and the factories, which are completely separate from the butter factories, are highly efficient, 2.5 lb. of cheese being obtained per pound of butterfat. It is compulsory for the cheese to remain fourteen days on the shelves of the factory curing rooms, after which it is railed to the coast and despatched to the cold stores at the shipping ports. Strict grading by Government graders is practised. Most cheese factories manufacture their whey into whey butter, which is used for cooking, 1 ton of whey butter being exported for every 60 tons of cheese produced. Only one factory in the Dominion manufactured processed cheese.

Recommendations.—It is suggested that the Batch system in Kenya should be superseded by some form of direct steam and vacuum process, as this would help to correct the results of a variable quality of cream, which is due largely to transport difficulties. Such a plant would cost about £900 landed in Kenya to be installed in one of the creameries for experimental purposes.

It is suggested that the existing transport organization should be entirely reviewed and where a group of suppliers are willing to send in their supplies daily by road the company should assist in organizing such transport up to a cost of ½d. per pound of butterfat. This is undoubtedly an excellent scheme to try on an experimental scale but, when distances and the smaller output per producer in this country as compared with New Zealand are considered, it may be found that the time is not yet ripe for the scheme.

The lack of Government services to assist the Kenya industry in testing in the creameries, in checking and grading cream, and in periodic inspection of farm dairies and plants is stressed and a request is made for the appointment of at least one dairy officer forthwith to assist generally in further development and to frame a Dairy Industry Act. In addition, it is suggested that a qualified dairy chemist should be appointed to carry out the necessary routine tests and such other research work as may be necessary. Further, that a stock inspector should be appointed for general dairy-farm inspection and instructional duties, the whole organization to be the nucleus of a Dairy Division. While there is little doubt that these services would be of great value and are in fact highly necessary, it might be necessary for Government and the dairy industry to pay equal shares of the cost on the lines of some of the similar services in New Zealand, since the wide area over which the dairy industry is scattered in Kenya will tend to increase the cost of these services. It is probable that the appointment of one officer would be sufficient at present.

Minor recommendations include that a period testing experiment should be tried at one of the creameries, to ascertain what variations, if any, in the total butterfat credited would be likely to result. When future replacements of churns are made, they should be of the internal worker type, so as to render the moisture content of the butter more even. Every effort should be made to increase the cold storage facilities at the Coast both in Government stores and in carrying steamers. The Railway should be urged to improve the present refrigerator vans and to explore the possibilities of supplying them with self-contained refrigerating units.

It is recommended that equipment for the flash pasteurization of milk for cheese should be installed at Naivasha as soon as possible. The manufacture of

casein cannot be recommended at the present time. Finally, the box shooks when supplied in more than one piece and joined should be held together with corrugated fasteners.

It is important to note that Mr. Chater's recommendations do not offer any solution of the problem of disposal of either skim milk, buttermilk or whey. It is felt that the Kenya Co-operative Creameries might well give a lead in this matter by the production of porkers of a type suitable for export at one at least of their creameries, where the problem of surplus buttermilk and whey is acute, and that their help should be forthcoming in assistance towards the establishment of an export industry for pig products. It is a pity that the General Manager did not state this in his otherwise most comprehensive report since the export of these products ranks high in the agricultural output of New Zealand and he is known to be personally extremely interested in the problem.

In conclusion, tribute should be paid to Mr. Chater for the invaluable information he has obtained and the excellent manner in which it is presented. The majority of it is likely to be of great value to the industry and the implementing of his recommendations should lead to an improvement in the quality of Kenya butter. R. S. B.

CONTRIBUTION TO THE CHEMICAL STUDY OF LEGUMINOUS INSECTICIDES OF THE BELGIAN CONGO. Mem. Inst. Roy. Col. Belge. (in French) *by* E. Castagne (102 pages, 9 plates) 1938.

Part I (35 pages) consists of a useful sumary of the toxic constituents found in leguminous insecticides, with their chemical constitutions and properties: the standard methods of determining rotenone and similar compounds: the methods of extracting the toxic constituents: the toxicity of these plants and their products. Apart from a modified apparatus used in extracting the toxic constituents there appears to be no original work in this part.

Part II (67 pages) is a study of several leguminous plants with insecticidal properties: 4 Tephrosia, 1 Lonchocarpus, 3 Milletia and 2 Derris species are considered. Each plant is briefly described, and then follows, for each part of the plant containing toxic constituents, a very full chemical analysis, a useful description of the methods used by the author to separate the active products, with the properties of those isolated, and a very interesting study of the localization of the cells which contain the toxic substances. For the microscopic examination sections were so treated that these substances took on a blue colour. This is by far the most interesting part of the paper and very little work similar to this appears to have been done by other workers, except in Amani (*Ann. App. Biol.*, Vol. 24, 696–702, 1937) where *Derris elliptica* root has been fully studied and similar work on Mundulea is now almost completed. It is to be hoped that this aspect of the work will be more fully dealt with in future publications by M. Castagne, as it is of particular interest to Africa as a whole.

R. R. W.